Dec. 49

MACHINE DESIGN

December 1949

In This Issue

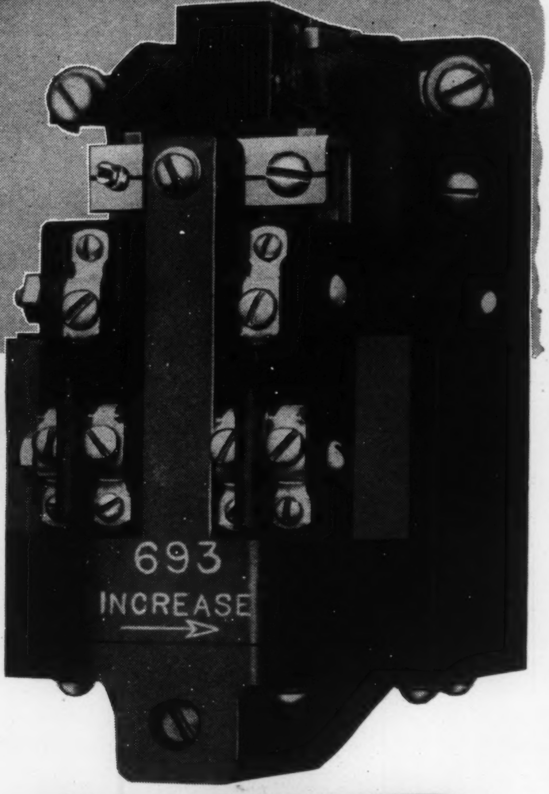
HYDRAULIC PACKINGS
COPPER-BASE ALLOYS
SHOP RELATIONSHIPS
BALANCING ACCURACY
CIRCUIT ANALYSIS

Contents, Page 3

For machine designers . . .

2 New Cutler-Hammer Timers

- SMALL SIZE
- EASY TO ADJUST
- ACCURATE AND DEPENDABLE



BULLETIN 10337 A. C. PNEUMATIC TIMER

Designed for a broad variety of industrial control timing needs, such as machine tools, conveyors, automatic processing equipment, etc. Its extremely small size, 2¾ wide x 4⅞ high makes it desirable where space is at a premium. Its timing adjustment is especially simple, made with a screw driver from the front. 8 turns of the screw gives the entire timing range from 0.3 seconds to 3 minutes. Reset is practically instantaneous. Available either with one timing step or two timing steps, the two steps eliminate the need of one timing relay. The two steps of timing are independently adjustable over the entire range.

BULLETIN 13522 GENERAL PURPOSE ELECTRONIC TIMER

For use particularly where short or very accurate timing is required. The standard unit has a wide timing range, from 0.15 to 60 seconds. Shorter time settings or narrower ranges can readily be provided for special applications. Timing adjustment is easily made by turning knob of potentiometer rheostat which is equipped with a clearly graduated dial. The rheostat may be located inside the timer enclosure or at any convenient place on the machine remote from the timer. A heavy duty industrial type relay is used in the timing circuit. An outstanding feature is the extreme accuracy of the unit on repeat operations and under varying ambient temperature conditions.

For further information on Bulletin 10337 pneumatic timer, or Bulletin 13522 electronic timer, write CUTLER-HAMMER, Inc., 1310 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
MOTOR CONTROL
C-H

NO. 13522-H2
110V AC
60CY
SHORT:
MIN 0.15 SEC
MAX 12 SEC
LONG:
MIN 0.30 SEC
MAX 60 SEC
CONNECT FOR SHORT TIMING
0 1 2 3 4 5 6 7 8 9 10
1 2 3 4 5 6 7 8

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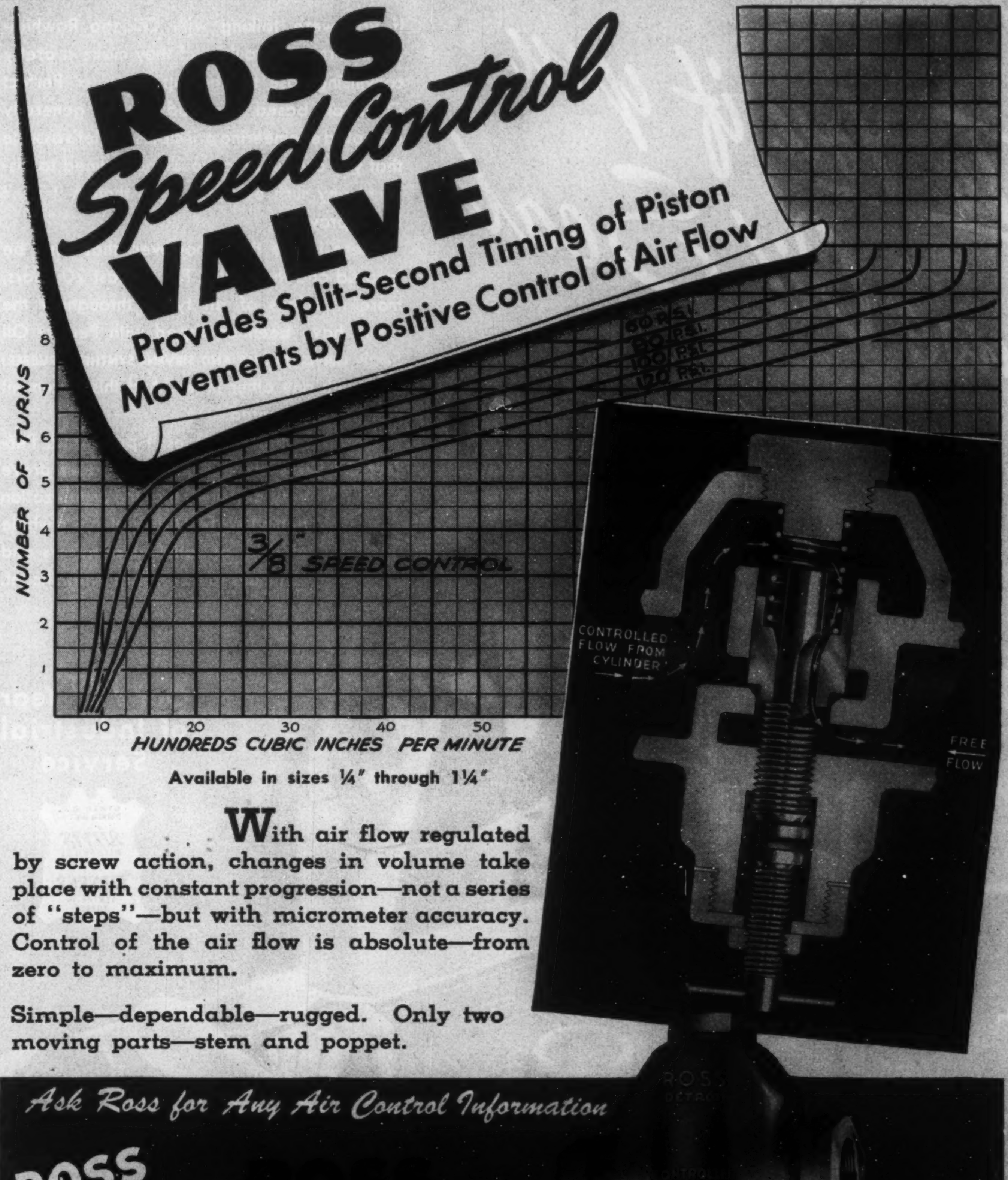
Provides Split-Second Timing of Piston Movements by Positive Control of Air Flow


NUMBER OF TURNS
1
2
3
4
5
6
7
8
60 P.S.I.
80 P.S.I.
100 P.S.I.
120 P.S.I.
3/8" SPEED CONTROL
10
20
30
40
50
HUNDREDS CUBIC INCHES PER MINUTE
CONTROLLED FLOW FROM CYLINDER
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There is one thing, however, that can't be ignored and that is this. For the last 20 years, more machines of all types throughout the world have been equipped with Perfect Oil Seals (SIRVIS LEATHER AND SIRVENE SYNTHETIC RUBBER) than with any other make. And this statement can be documented.

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PERFECT Oil Seals

This Month's Cover: View of floating work supports on Gisholt Dynetric balancing machine. Article discussing accuracy of balancing machines begins on Page 113.

MACHINE DESIGN

Vol. 21—No. 12 December, 1949

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

CONTENTS

Standards Are Everybody's Business (Editorial) 101

Engineering and Shop Relationships 102
By Harold A. Bolz

Scanning the Field for Ideas 111
Sapphire inserts—ceramic materials—constant-flow regulator

Determining Balancing Accuracy 113
By Werner I. Senger

History of Machine Hydraulics—Part II—Reciprocating Pumps 120
By H. G. Conway

Panel Meter Redesigned—with emphasis on economy 122
By Bradley Thompson

Which Copper-Base Alloy? 125
By R. Carson Dalzell and Joseph J. Matt

Floating-Rotor Motor—in package unit 135

Relay Circuit Analysis—by "odd-even" algebra 137
By Edward C. Varnum

Mechanical Kidney Developed 140

Production Processes—Part XLIX—Plaster-Mold Casting 141
By Roger W. Bolz

Centrifugally Controlled Drive—for motor-bike transmission 146

Electronic Regulators and Regulating Systems 147
By W. G. Roman

Contemporary Design 150
Modern business machine styling

Hydraulic Packings for Industrial Equipment (Data Sheet) 155
By J. N. Smith

DEPARTMENTS

Itemized Index 7
Topics 98
Production and Design 154
New Parts and Materials 161
Engineering Dept. Equipment 168
Helpful Literature 173
Men of Machines 176
News of Manufacturers 180
Noteworthy Patents 184
Sales and Service Personnel 188
Sales Notes 194
Meetings and Expositions 197
Design Abstracts 200
New Machines 218

ANNUAL INDEX OF EDITORIAL CONTENTS .. 233

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DESIGNING FOR PRODUCTION AND SALES • STYLING
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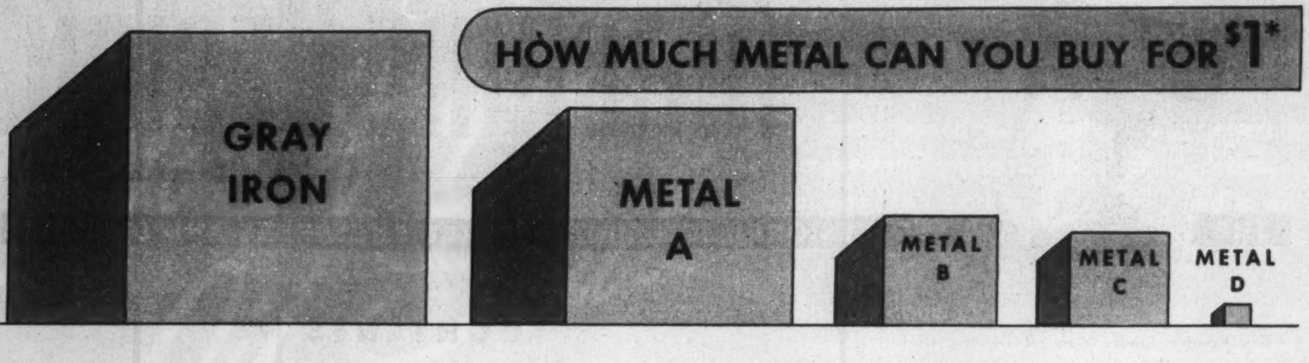
MACHINE COMPONENTS • ENGINEERING MANAGEMENT



ECONOMY is one of 11 reasons why GRAY IRON LEADS THE FIELD!

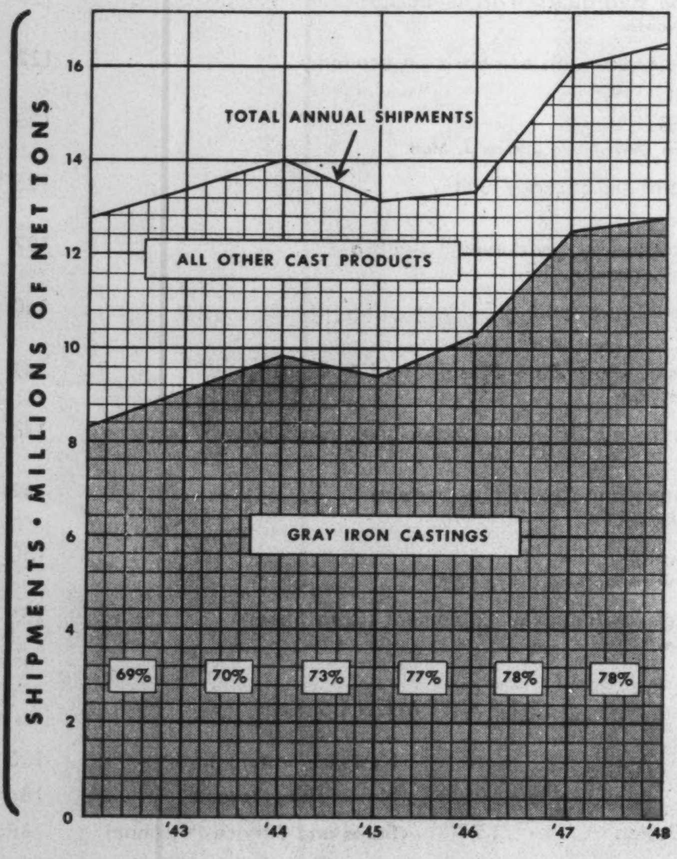


*Chart based on the comparative costs of raw materials (Materials & Methods—Engineering File Facts, Number 156—March, 1948).

Where you need volume *and* weight for stability and rigidity, Gray Iron gives you the greatest economy. You can buy more of it per dollar than any other metal. (See chart above.)*

But ultimate economy is only one of 11 reasons for Gray Iron's increasing popularity. Its other advantageous characteristics include:

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- Rigidity
- Low Notch Sensitivity
- Wear Resistance
- Heat Resistance
- Corrosion Resistance
- Machinability
- Vibration Absorption
- Durability
- Wide Strength Range

These are the reasons for the steady increase in the use of Gray Iron as against all other cast products. (See chart at left.)

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CARRY HEAVY LOADS WITH COMPLETE RELIABILITY

IF YOUR POWER TRANSMISSION PROBLEM IS ONE OF
LOAD, SPEED OR ANGLE
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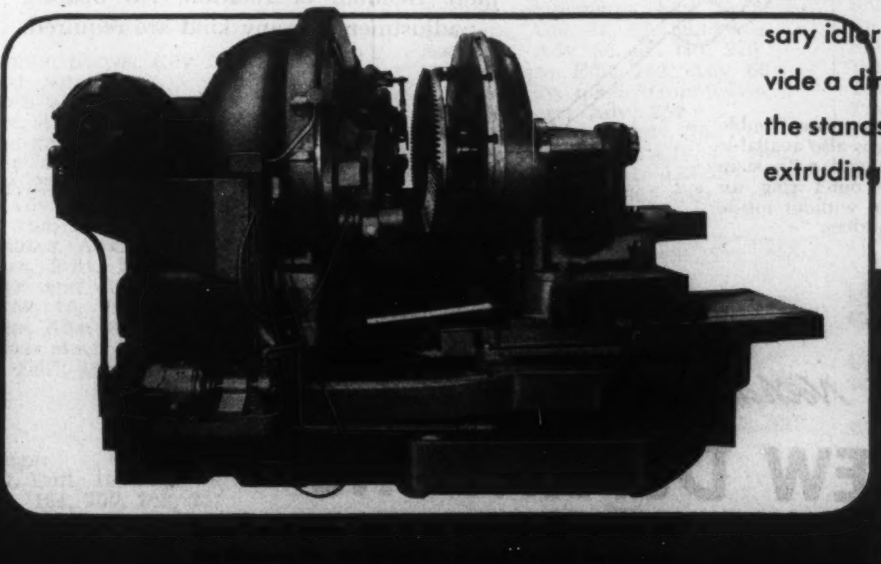

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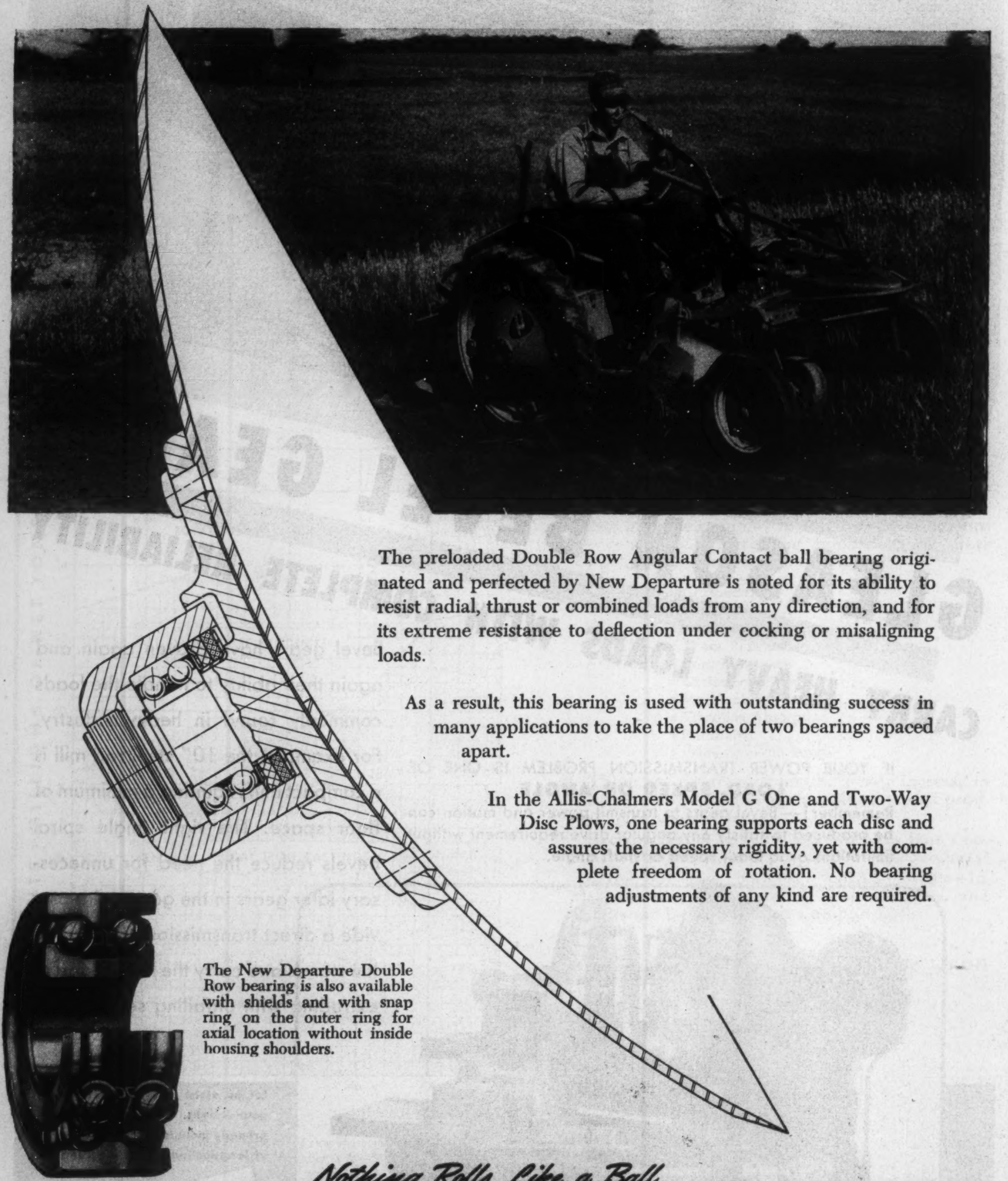

WHERE 1+0=TWO

The preloaded Double Row Angular Contact ball bearing originated and perfected by New Departure is noted for its ability to resist radial, thrust or combined loads from any direction, and for its extreme resistance to deflection under cocking or misaligning loads.

As a result, this bearing is used with outstanding success in many applications to take the place of two bearings spaced apart.

In the Allis-Chalmers Model G One and Two-Way Disc Plows, one bearing supports each disc and assures the necessary rigidity, yet with complete freedom of rotation. No bearing adjustments of any kind are required.

The New Departure Double Row bearing is also available with shields and with snap ring on the outer ring for axial location without inside housing shoulders.

Nothing Rolls Like a Ball

NEW DEPARTURE

BALL BEARINGS

NEW DEPARTURE • Division of GENERAL MOTORS CORPORATION • BRISTOL, CONNECTICUT • BRANCHES IN ALL PRINCIPAL CITIES

ITEMIZED INDEX

Classified for convenience when studying specific design problems

Design and calculations

- Balancing, determining accuracy of, Edit. 113-119
- Bearings, rubber for rocker arm, Edit. 154
- Business machines, Edit. 150-153
- Casting, plaster-mold, Edit. 141-145
- Copper-base alloys, Edit. 125-134
- Engines, high-compression, Edit. 200
- Inserts, sapphire, for wear resistance, Edit. 111
- Management of young engineers, Edit. 124
- Management, engineering and shop relationships, Edit. 102-110
- Mechanical kidney, Edit. 140
- Meters, panel, redesign of, Edit. 122-124
- Motors, floating-rotor, Edit. 135-136
- Packings, hydraulic — (Data Sheet), Edit. 155-160
- Quality control, Edit. 208, 212
- Regulator, constant flow, Edit. 112
- Regulators and systems, electronic, Edit. 147-148
- Relay circuit analysis, Edit. 137-139
- Specifications, Edit. 204
- Torque converters, Edit. 216
- Transmission, two-speed, for motor bikes, Edit. 146

Engineering department

- Equipment, Edit. 168, 170, 172; Adv. 62, 63, 179, 222
- Management, Edit. 102-110, 124
- Supplies, Adv. 63, 207, 274
- Experimental equipment, Edit. 168, 170, 172; Adv. 261

Materials

- Aluminum alloys, Adv. 22, 175, 241
- Babbitt, Adv. 32
- Bismuth alloys, Edit. 166
- Bronze, Adv. 206, 276
- Carbon-graphite, Adv. 16, 17, 190
- Copper alloys, Edit. 125-134; Adv. 29, 213
- Felt, Adv. 268
- Gray iron, Adv. 4
- Laminates, Adv. 227
- Plastics, Edit., 122-124; Adv. 23
- Rubber and synthetics, Edit. 165; Adv. 45, 78
- Silicone, Adv. 188
- Stainless steel, Adv. 43, 221
- Steel, Edit. 166; Adv. 99, 214

Parts

- Bearings:
  - Ball, Edit. 163; Adv. 6, 13, 28, 64, 73, 194, 200, 209, 251
  - Carbon-graphite, Adv. 182
  - Pillow blocks, Adv. 96, 249, 270
  - Roller, Edit. 163; Adv. 13, 64, 73, 91, 194, 215, 251, back cover
  - Sleeve, Adv. 74, 93, 178, 264, 270, 279
- Bellows assemblies, Adv. 27, 167
- Belts, Edit. 165; Adv. 56, 94
- Blower wheels, Adv. 252
- Brakes, Adv. 177, 187, 223
- Brushes, carbon, Adv. 81
- Carbon-graphite parts, Adv. 16, 17, 190
- Castings:
  - Centrifugal, Adv. 183
  - Die, Adv. 18, 59, 241
  - Investment, Adv. 58, 92
  - Permanent mold, Adv. 22, 59
  - Plaster mold, Edit. 141-145
  - Sand, Edit. 166; Adv. 4, 12, 22, 51, 59, 205, 206, 226
- Chains:
  - Conveyor, Adv. 61
  - Roller, Adv. 60, 77
  - Silent, Adv. 46, 47
- Clutches, Adv. 187, 223, 250, 256, 272, 277
- Controls (see Electric etc.)
- Counters, Adv. 281
- Couplings, Edit. 166; Adv. 25, 61, 245, 254, 271
- Drives, adjustable speed, Adv. 35, 38, 39
- Electric accessories, Adv. 260, 272
- Electric controls:
  - Circuit breakers, Edit. 162
  - Collector rings, Adv. 271
  - Contactors, Adv. 254
  - Control stations, Adv. 65
  - Electronic, Edit. 112
  - Rectifiers, Adv. 36, 257
  - Relays, Edit. 137-139, 164; Adv. 95, 263
  - Resistors, Edit. 163, 164; Adv. 192
  - Rheostats, Adv. 193
  - Servos, components, Adv. 75
  - Starters, Adv. 42, 67, 68, 243
  - Switches, Adv. 36, 66, 191, 270
  - Thermostats, Edit. 163; Adv. 66
  - Timers, Adv. inside front cover
  - Transformers, Adv. 252
- Electric generators, Adv. 75
- Electric heating units, Adv. 70, 198
- Electric motors, Edit. 135-136, 161, 162, 164, 165, 166; Adv. 11, 14, 15, 20, 21, 35, 38, 39, 49, 50, 53, 54, 55, 83, 100, 186, 201, 210, 217, 242, 247, 254, 259, 265, 268, 274, inside back cover
- Engines, Edit. 165, 200; Adv. 264, 266
- Fasteners:
  - Blind, Adv. 10
  - Inserts, Edit. 111
  - Locking washers, Adv. 80, 256, 274
  - Nuts, bolts, screws, Adv. 26, 80, 169, 184, 211, 229, 232, 267, 282
- Felt parts, Adv. 268
- Filters, Adv. 93
- Fittings, Adv. 195
- Floor plates, Adv. 202
- Forgings, Adv. 175
- Gages, pressure, etc. (see Instruments), Adv. 8
- Gears, Adv. 5, 12, 19, 53, 224, 228, 230, 242, 265, 272
- Heat exchangers, Adv. 88
- Hose (see Tubing)
- Hydraulic equipment:
  - Cylinders, Adv. 44, 82, 196, 220, 262, 269
  - Pumps, Edit. 163, 165; Adv. 212, 240
  - Systems, Adv. 9, 85, 260, 275, 277
  - Valves, Edit. 164; Adv. 52, 220, 266, 269
- Instruments, Edit. 122-124; Adv. 37
- Insulation, Adv. 188
- Joints, Edit. 162; Adv. 260
- Lubricators and equipment, Edit. 162; Adv. 57
- Machined parts, Adv. 226
- Meters, Edit. 122-124
- Motors (see Electric motors)
- Mountings, vibration, Adv. 226
- Pneumatic equipment:
  - Cylinders, Adv. 197
  - Valves, Edit. 161; Adv. 1, 52, 266
- Powder-metal parts, Adv. 93, 199, 203
- Pulleys and sheaves, Adv. 275
- Pumps (see also Hydraulic), Adv. 76, 89, 208, 258, 262, 271
- Reducers, speed, Adv. 87, 218, 248, 256, 277
- Regulators, Edit. 112
- Rings, Adv. 215
- Rolls, Adv. 40
- Rubber and synthetic parts, Adv. 45, 78, 266
- Seals, packings, gaskets, Edit. 155-160, 161, 163; Adv. 2, 24, 36, 45, 48, 69, 73, 79, 171, 244, 277
- Shafts, flexible, Adv. 224, 275
- Sheaves, Adv. 270
- Shims, Adv. 204
- Springs, Adv. 84, 262
- Sprockets, Adv. 61, 232
- Terminal blocks, Edit. 166
- Torque converters, Edit. 216
- Transmissions, variable speed, Edit. 146, 161, 162; Adv. 9, 30, 31, 180, 187, inside back cover
- Tubing:
  - Flexible, metallic, Adv. 41, 71, 230
  - Flexible, nonmetallic, Edit. 164
  - Seamless, Adv. 181, 185, 189, 216, 219, 221
  - Welded, Adv. 90, 219
- Universal joints, Adv. 252, 258
- Valves (see also Hydraulic and Pneumatic), Adv. 246, 264, 268
- Vibrators, Adv. 36, 253
- Weldments and equipment, Adv. 97, 215, 225, 231
- Wire and wire products, Adv. 176, 276

Production

- Balancing and equipment, Edit. 113-119; Adv. 86, 258
- Machines, special, Adv. 255

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* Original Equipment Manufacturers

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They know that US Instruments give more service, more accuracy, more *value* for the money. They know USG can supply all their needs—from highly specialized instruments measuring as low as 1" of mercury absolute, to standard type gauges measuring from 30" vacuum to 100,000 pounds pressure per square inch. And they know that for more than 40 years US Gauges have been the standard of dependability. So more original equipment manufacturers specify US Gauges than any other make.

Next time you order gauges, follow the lead of these satisfied users . . . buy US Gauges. For more information about US Gauge write today. United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Penna.

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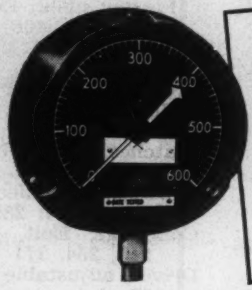
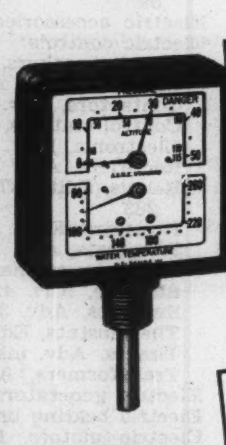


TURRET CASE GAUGES

A complete line of bakelite turret case gauges conforming to current U. S. Navy specifications. For general use in refinery, chemical or power plants. Bourdon tube of phosphor bronze or stainless steel conforming to Navy types A or B. Movement of corrosion resistant bronze and nickel silver construction. Socket, spring, movement and dial are an integral unit removable from case for testing. Micrometer adjustable pointer, separate adjustable red hand. Accuracy ½ of 1% for middle third of scale and 1½% maximum scale range of balance. Ranges up to 5000 P.S.I.



COMBINATION THERMOMETER AND ALTITUDE GAUGES

For installation on domestic hot water heating systems. Indicates on one dial: water temperature, altitude of water above gauge. Wide phosphor bronze Bourdon tube. All brass heavy-duty movement. Temperature indicating section of spiral bimetal strip connected to stainless steel shaft operating in phosphor bronze bearing. Heavy pressed steel case with low or back male connection. Ranges 60° to 260°F. 0 to 115 feet of water.

DUPLEX GAUGES

For use on equipment where it is desired to indicate two related pressures on one dial such as in: air brake systems, pneumatic receivers, differential pressure indicators, etc., with any media that will not attack brass or bronze. Two single phosphor bronze Bourdon tubes are independently mounted and connected to two separate threaded external socket connections. Specially constructed multiple plate quill type movement of brass throughout. Cast iron case, but available in a number of special case designs for close mounting. Lower or low back side-by-side connections. Accuracy 2% of scale range. Ranges up to 1000 P.S.I.

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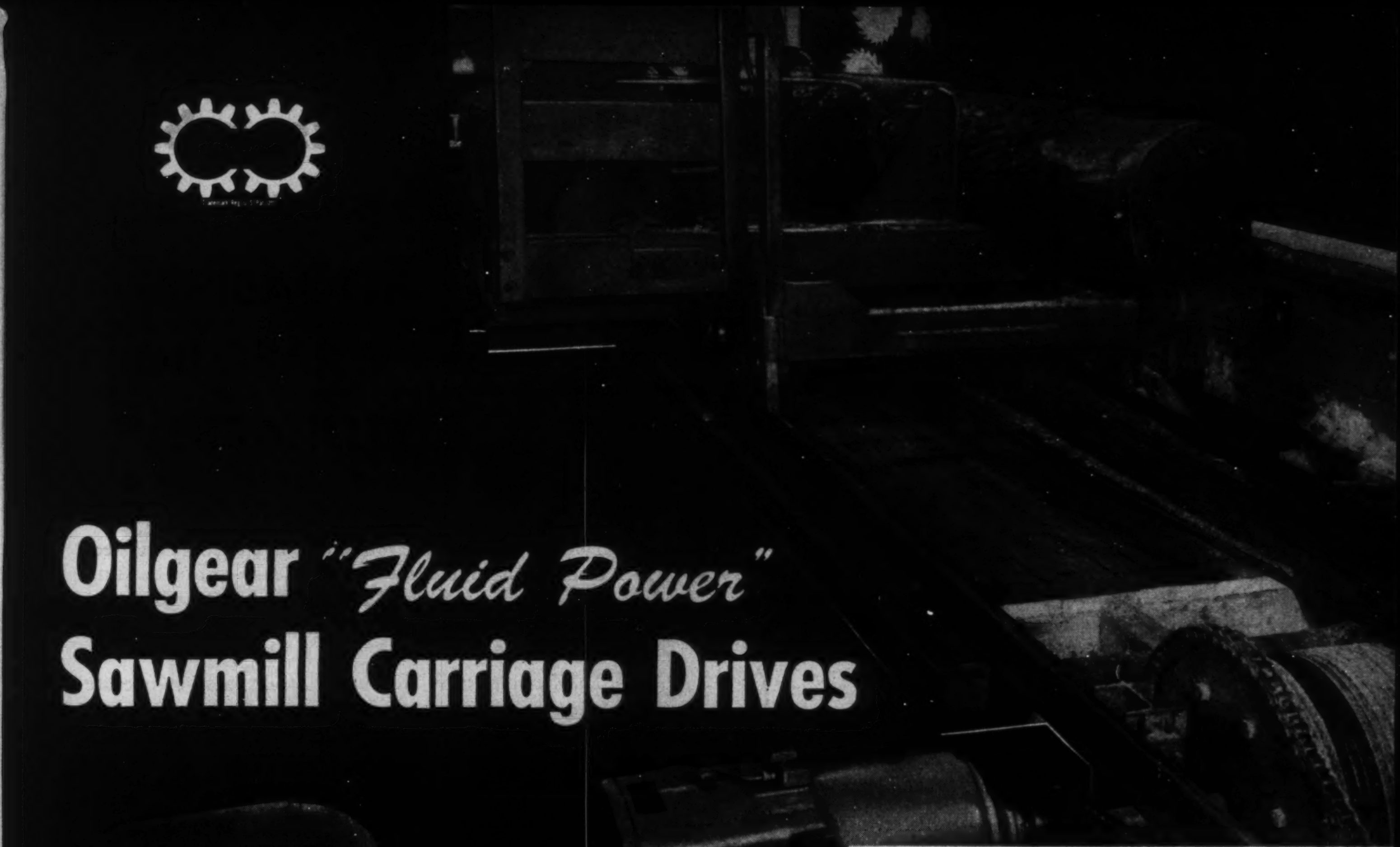
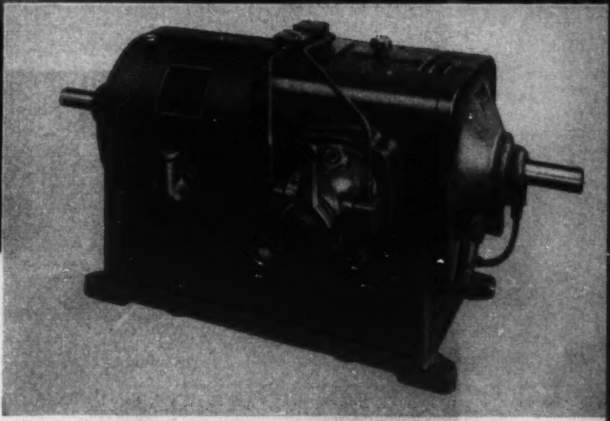


Oilgear "Fluid Power" Sawmill Carriage Drives



Oilgear 20 H. P. Two-Way Variable Speed Transmission for Sawmill Carriage Drive.

One of hundreds of applications

Oilgear Fluid Power equipment is used on many different types of machines and processes throughout industry. It is used to drive infinitely delicate process equipment as in photographic film making, printing on cellophane, maintaining the exceedingly thin web in paper-making or dyeing light rayon fabrics.

It is also used where exceptional speed control is needed as in the lumber industry. An Oilgear Sawmill Carriage Drive is small, powerful, and self-contained. It can be coupled to a standard a.c. motor, a diesel or gas engine or mill lineshaft. Its simple, integral control lever gives the sawyer complete command of the sawmill carriage, quick and selective control of carriage speeds, *infinite* speed control in either direction . . . hydro-dynamic braking with regenerative power that's inherent in the system, cushioned and shock-free. There is no possibility of overshoot or runaway.

Second, there's no power plant, no auxiliary equipment, no generator set, no complicated, easy-to-get-out-of-order control mechanism. Nothing can hurt these battleship-built drive units which have proven successful for over a quarter century on other tough drives. Using available alternating current, you convert wood waste to profit instead of fuel, and need no steam engineer.

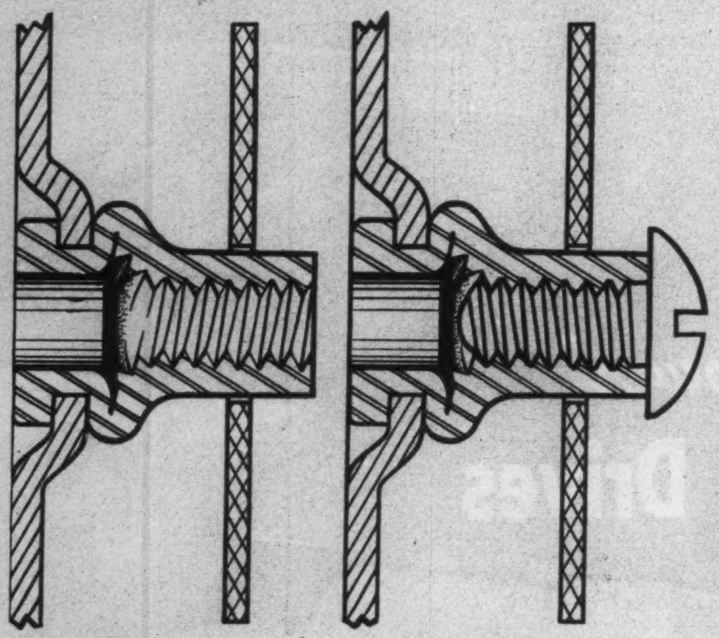
Third, its operating mechanism is fully enclosed and automatically lubricated. No frequent servicing necessary. Merely change oil every 4 to 8 months.

Oilgear Fluid Power equipment is also used on gang saw feed rolls, set works and holding dogs, edgers, conveyors, veneer lathes, surfacers, hot plate presses and baling presses. In the pulp and paper industry it is used on paper machine drives, calender drives, winder drives, unwinder drives, hold-down systems.

Any machine designer, any manufacturer, can investigate versatile, profitable Oilgear to advantage. THE OILGEAR COMPANY, 1568 W. Pierce St., Milwaukee 4, Wisconsin.

Oilgear Fluid Power

RIVNUTS improve design, cut assembly costs in new lighting fixture



RIVNUT USED AS A LATCH

RIVNUT USED AS A HINGE

Pittsburgh Reflector Company uses Rivnuts as both hinge and latch in "Monroe" fluorescent luminaire

Designers of the new "Monroe" fluorescent luminaire were looking for a fastener that would serve as both hinge and latch to attach the "egg crate" type light shield. They found the perfect answer in Rivnuts—the only one-piece blind rivet with threads.

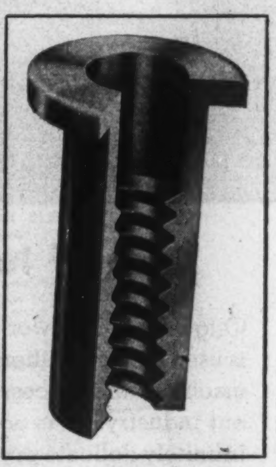
Two $\frac{7}{16}$ in. Rivnuts are inserted in the 20-gauge steel end panels and upset with an easy-to-use heading tool. The bulge formed in the Rivnut grips the panel tightly. At least 6 threads remain clean to take an attachment screw.

The Rivnuts provide a neat, strong, easy-to-operate hinge and latch combination. And many man-hours of assembly time are saved by the speed and ease of Rivnut installation.

Chances are Rivnuts can solve your fastening problems, too. Get the help of Rivnut engineers. Write *The B. F. Goodrich Company, Dept. MD-129, Akron, O.*

One man installs Rivnut in about two seconds. It aligns itself positively. Flat head fits flush. Does not mar finish.

"Egg crate" louver has spring steel members on each end that hinge and latch to Rivnuts. Opens in one simple operation (no tools) for easy maintenance.



Rivnut can serve as either hinge (with attachment screw) or latch.

B.F. Goodrich

RIVNUTS

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Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives proved applications. Write for your free copy today to The B. F. Goodrich Company, Dept. MD-129, Akron, Ohio.

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- ☑ **INDIVIDUALLY TESTED.** Each motor receives a thorough commercial test before leaving the plant.
- ☑ **NATIONALLY SERVICED.** Baldor Motors are sold and serviced in more than 200 Trade Centers.

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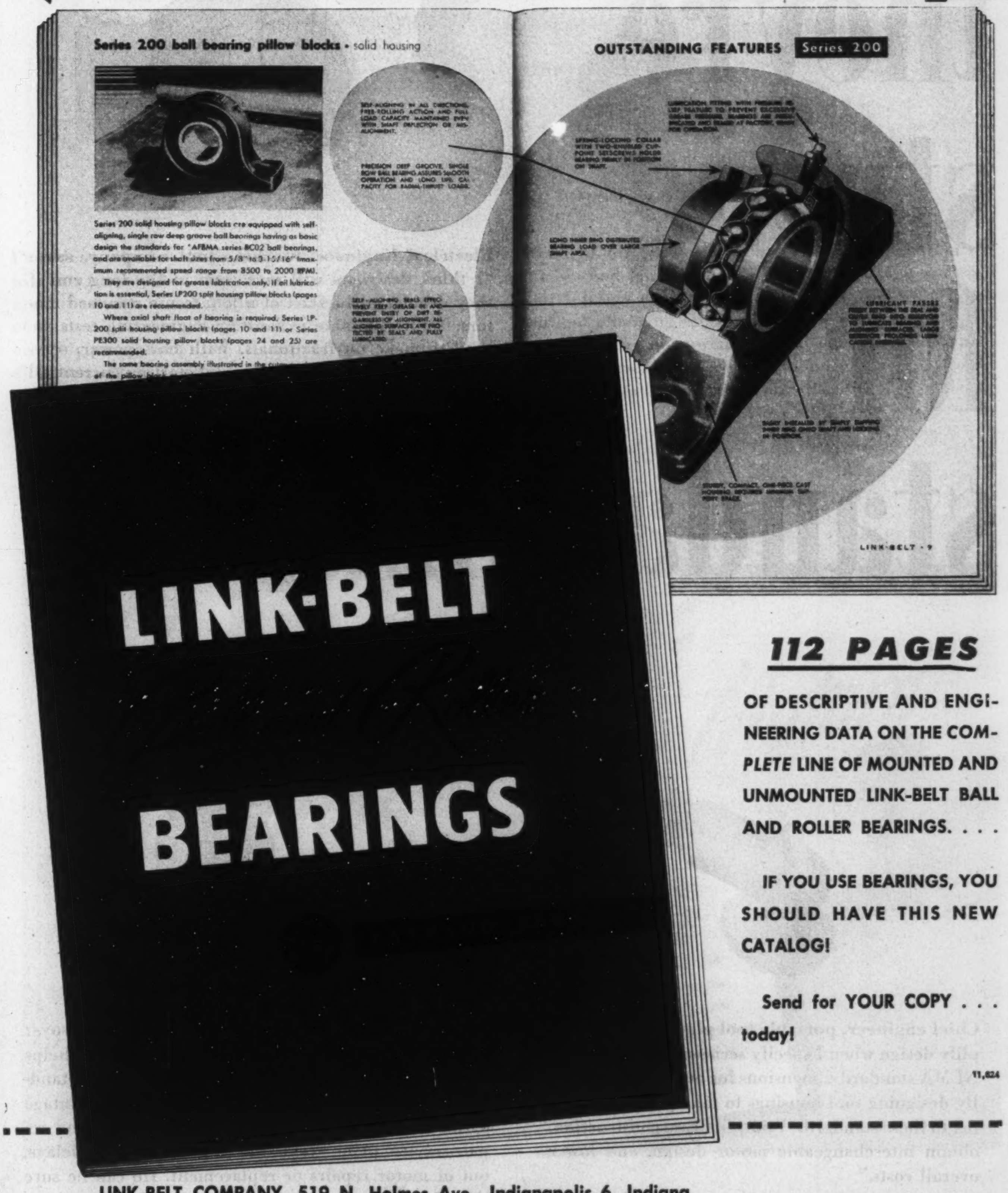

Series 200 ball bearing pillow blocks • solid housing

Series 200 solid housing pillow blocks are equipped with self-aligning, single row deep groove ball bearings having as basic design the standards for *AFBMA series BC02 ball bearings, and are available for shaft sizes from 5/8" to 3-15/16" (maximum recommended speed range from 8500 to 2000 RPM).

They are designed for grease lubrication only. If oil lubrication is essential, Series LP200 split housing pillow blocks (pages 10 and 11) are recommended.

Where axial shaft float of bearing is required, Series LP-200 split housing pillow blocks (pages 10 and 11) or Series PE300 solid housing pillow blocks (pages 24 and 25) are recommended.

The same bearing assembly illustrated in the cut… of the pillow block…

OUTSTANDING FEATURES **Series 200**

SELF-ALIGNING IN ALL DIRECTIONS. FREE-ROLLING ACTION AND FULL LOAD CAPACITY MAINTAINED EVEN WITH SHAFT DEFLECTION OR MISALIGNMENT.
PRECISION DEEP GROOVE, SINGLE ROW BALL BEARING ASSURES SMOOTH OPERATION AND LONG LIFE. CAPACITY FOR RADIAL-THRUST LOADS.
SELF-ALIGNING SEALS EFFECTIVELY KEEP GREASE IN AND PREVENT ENTRY OF DIRT REGARDLESS OF ALIGNMENT. ALL ALIGNING SURFACES ARE PROTECTED BY SEALS AND FULLY LUBRICATED.
LUBRICATION FITTING WITH PRESSURE RELIEF FEATURE TO PREVENT EXCESSIVE GREASE PRESSURE. BEARINGS ARE PRELUBRICATED AND SEALED AT FACTORY, READY FOR OPERATION.
SPRING-LOCKING COLLAR WITH TWO-KNURLED CUP-POINT SETSCREWS HOLDS BEARING FIRMLY IN POSITION ON SHAFT.
LONG INNER RING DISTRIBUTES BEARING LOAD OVER LARGE SHAFT AREA.
LUBRICANT PASSES FREELY BETWEEN THE SEAL AND OUTER RING INTO RESERVOIR TO LUBRICATE BEARING AND ALIGNING SURFACES. LARGE RESERVOIR PROLONGS LUBRICATION INTERVALS.
EASILY INSTALLED BY SIMPLY SLIPPING INNER RING ONTO SHAFT AND LOCKING IN POSITION.
STURDY, COMPACT, ONE-PIECE CAST HOUSING REQUIRES MINIMUM SUPPORT SPACE.
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BEARINGS

112 PAGES

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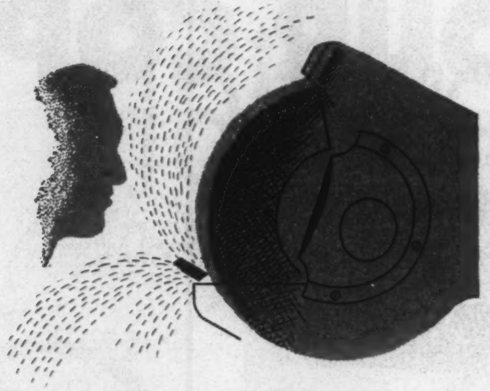
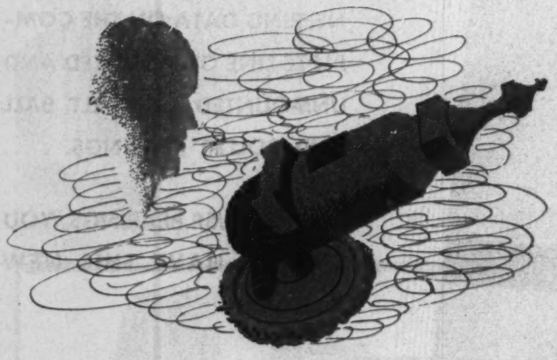
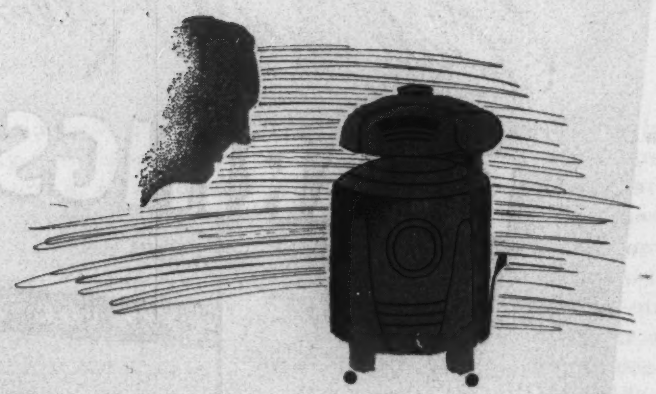


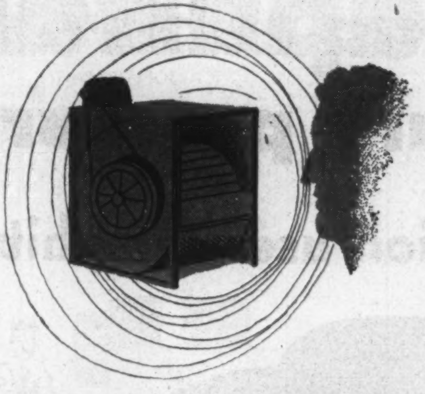
Electrical Engineer, machine tool company, says: "I think designers will save time in the long run if they decide, at the start of a job, to use standard motors. We'll eliminate exhaustive engineering tests we used to make on fractionals. With horsepower, service factor, breakdown torque, and starting current all rated on a clear-cut, uniform basis we'll know *in advance* that the motor will do the job."

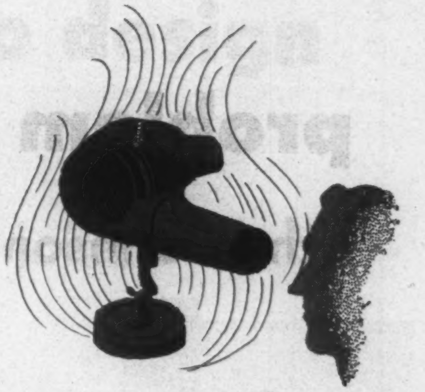




Chief engineer, portable tool plant, says: "I simplify design when I specify series-motor parts with NEMA standard dimensions for our portable tools. By designing tool housings to take parts conforming to these standards, I simplify case construction, obtain interchangeable motor design, and lower overall costs."

Vice-President, washing machine company, says: "The use of *standard* washing machine motors helps our dealers to give dependable service. With standard motors, the service man can take full advantage of the motor manufacturer's motor-exchange and repair-service plans—take the headaches, and delays, out of motor repairs or replacement. He can be sure that the motor he puts back on the job will perform as it should."





President, electric blower corporation, says: "The big thing about the new fractional-hp motor standardization plan, to me is that we stand a better chance of getting 'off-the-shelf' delivery of motors when they are a big-production item, instead of a special. Also, we eliminate special jigs and fixtures, and the need for making universal mounting bases and adapter plates."

Head of oil burner firm says: "Standardization of motors and parts is most important to our company. Our burners can be made in several sizes and types without changing the motor size or application, even when making improvements and new models. Standardization means lower production and inventory costs for oil burner manufacturer and distributor or dealer."

They use General Electric Standardized Motors

FRACTIONAL HORSEPOWER

WANT TO SEE whether a switch to standardized General Electric fractional-hp motors will pay off for you? Our engineers will be glad to give you the unvarnished facts. Just drop us a line giving the size, type and special characteristics of the motors you are now using. For general information about fractional-hp motor standards write for Bulletin GES-3565. Apparatus Department, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

700-99

graphitar
(CARBON-GRAPHITE)

problem in rotary pressure

the Johnson Corporation uses Graphitar

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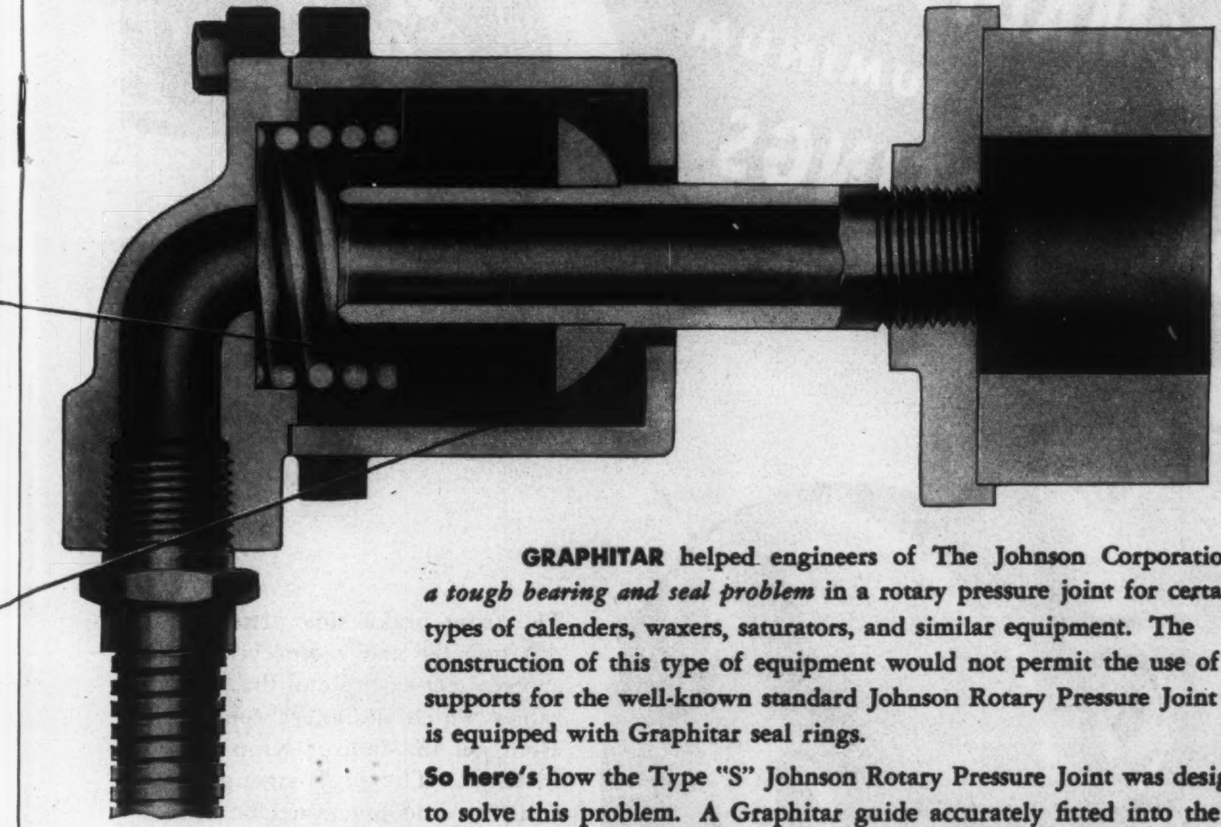
THE UNITED STATES GRAPHITE COMPANY

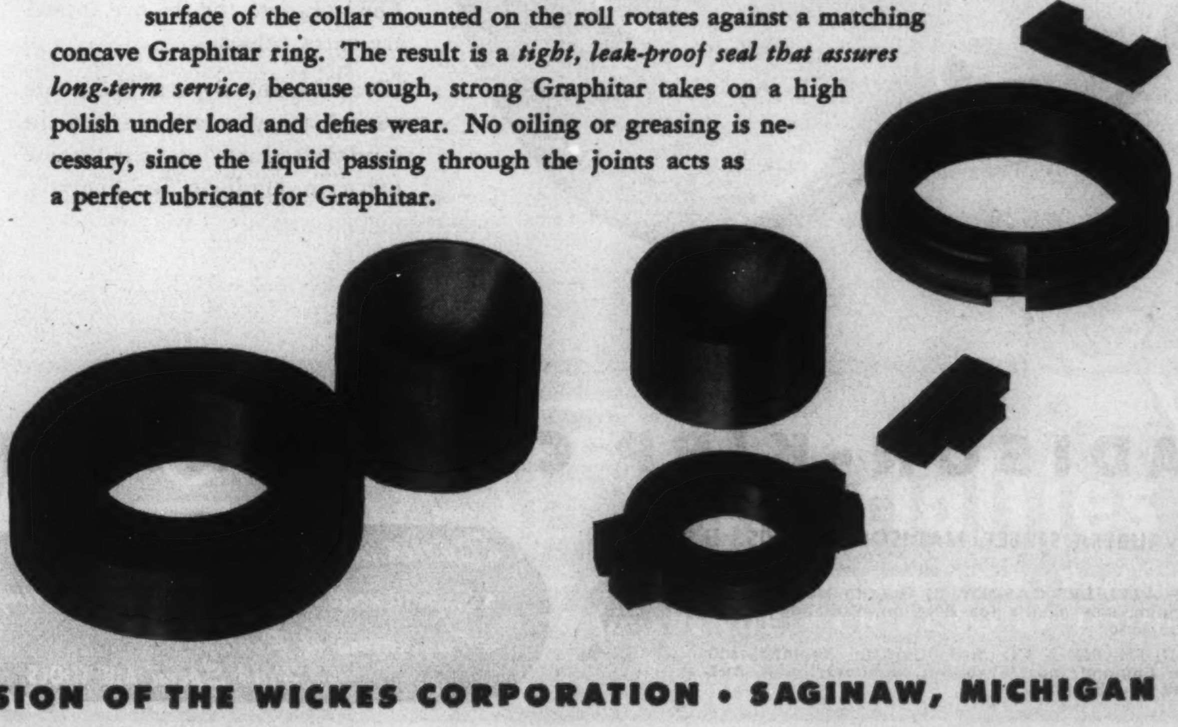
provides answer to design joint

Guide and Seal in Type "S" joint



GRAPHITAR helped engineers of The Johnson Corporation ***lick a tough bearing and seal problem*** in a rotary pressure joint for certain types of calenders, waxers, saturators, and similar equipment. The construction of this type of equipment would not permit the use of supports for the well-known standard Johnson Rotary Pressure Joint which is equipped with Graphitar seal rings.

So here's how the Type "S" Johnson Rotary Pressure Joint was designed to solve this problem. A Graphitar guide accurately fitted into the joint body, as illustrated, provides sufficient support. The convex surface of the collar mounted on the roll rotates against a matching concave Graphitar ring. The result is a ***tight, leak-proof seal that assures long-term service,*** because tough, strong Graphitar takes on a high polish under load and defies wear. No oiling or greasing is necessary, since the liquid passing through the joints acts as a perfect lubricant for Graphitar.



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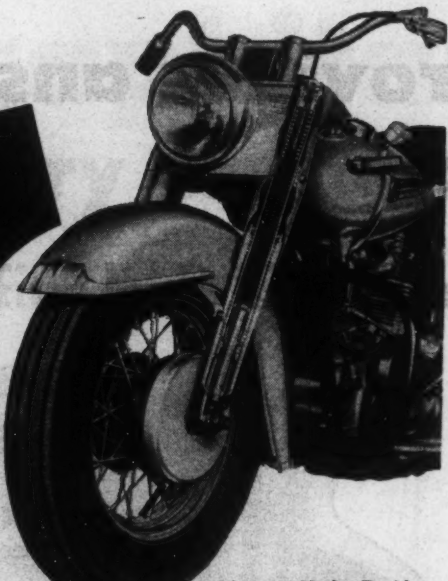

The 1950 Harley-Davidson
Hydra-Glide Motorcycle

Inside View
Outside View

The front brake side plate on this popular new motorcycle is an excellent example of the plus values which designers can so often get in Madison-Kipp die castings. The high strength, accuracy, and functional bosses and recesses are inherent values. The lightness and the eye appeal are extra values.

If you use metal parts in sizable quantities, you are invited to send your blueprints to our home office in Madison for analysis.

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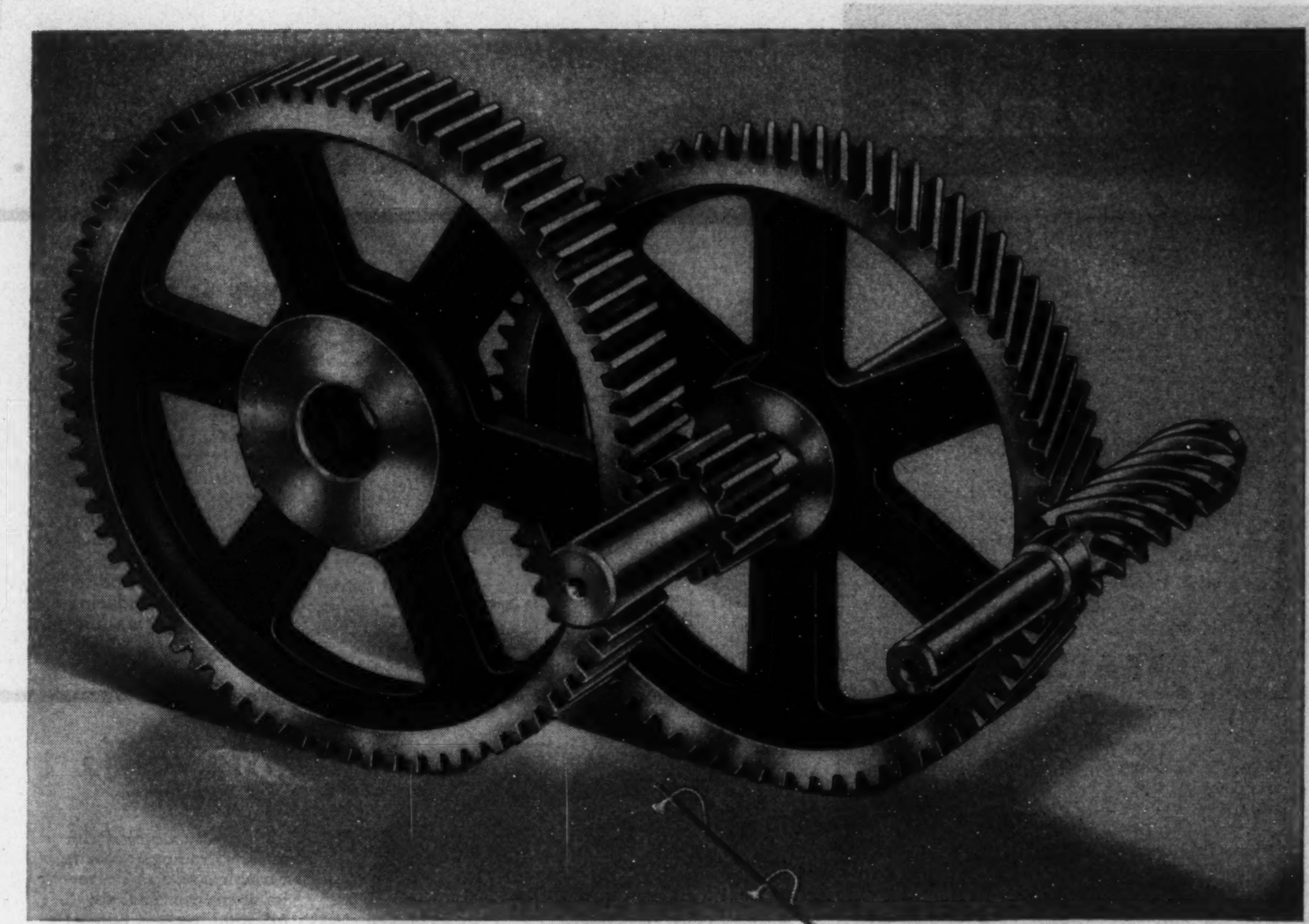
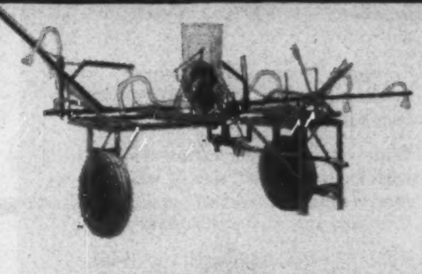


GEARS that help *Kill!*



The value of Insecticide Dusting for cotton and many other important crops has been proved beyond all question. Where breakdown or power failure could mean a sharply depreciated or lost crop, SIMPLEX MANUFACTURING COMPANY can take no chances. They specify G.S. for the Gears in their popular Insecticide Dusters, for smooth, trouble-free performance, for rugged *dependability* day in and day out. You'll find G.S. Small Gears in all types and kinds of products—those you use in your own home, those used in industry, in agriculture. *Wherever* long life, dependability, and quieter, smoother operation are factors, G.S. Small Gears are the right answer to the power problem. Our thirty years of experience in specializing on Fractional Horsepower Gears is yours to command. Let a G.S. Engineer give you ideas, suggestions, cost estimates. No obligation. Write or phone, today!

SEND FOR *free G. S. catalog-bulletin, describing many different types and applications of our Fractional Horsepower Gears.*

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BODINE Electric Company has earned an enviable reputation throughout industry as designer and manufacturer of high-quality fractional horsepower motors. Nearly a half-century's experience has given us the know-how to provide you with motors best suited to your particular application. Bodine motors are used on many of the nation's leading products. Experienced application engineers are always at your disposal to help solve your motor application problems.

FEATURES

- Motors engineered to your product.
- Broad line of motors to select from—over 3500 standard specifications from 1/2000 to 1/6 hp.
- Quiet operation, reliable, trouble-free, precision-made.
- Whether a.c. or d.c. the frame is the same size—same mounting dimensions — 100% interchangeability.
- Compact, dependable power in smallest possible space—a standard frame for each horsepower rating.
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- Built to rigid standards . . . high-grade craftsmanship . . . quality materials . . . attractive appearance.

AVAILABILITY

Bodine motors, in most of the popular specifications, can be supplied from stock. Others can be produced in 6 to 12 weeks—test motors, 3 to 8 weeks. Bodine is prepared to supply motors to meet your production requirements.

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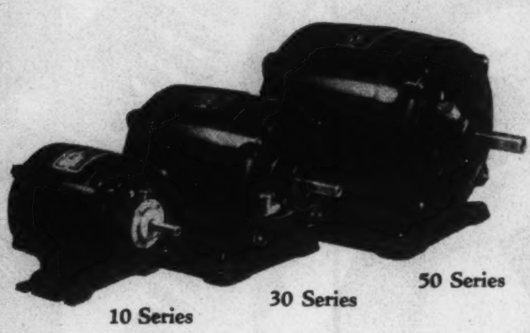
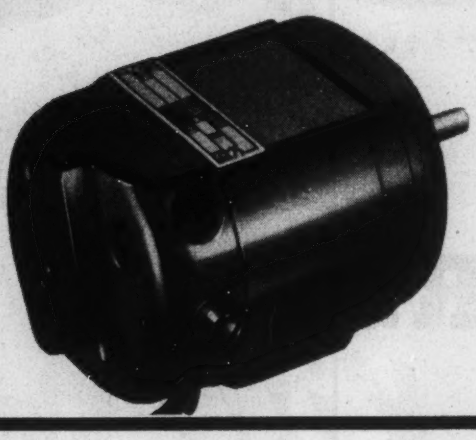


TYPE N MOTOR

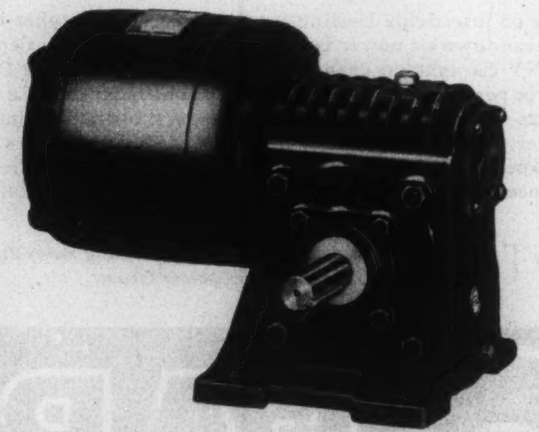
Available in three basic sizes. Smallest motor is 3⅜" in diameter, largest is 5½". Almost any type of winding. Standard ratings from 1/150 to 1/6 hp at 1725 rpm. Used on such devices as blowers, pumps, coin-handling equipment, communication equipment, therapeutic devices, sound-recording and reproducing equipment, and machine tools.



TYPE VCF-12 MOTOR

Normally supplied with series windings having variable-speed characteristics and nominal speed of 5000 rpm. Compact (2¼" high), generous power, lightweight, small enclosure. Operates such devices as adding machines, calculating machines, check protectors and motion-picture projectors.

SPEED



Group 7: Rugged reducer for driving heavy loads continuously. Ample reserve for overloads. Height, 7⅞". Eight different windings.

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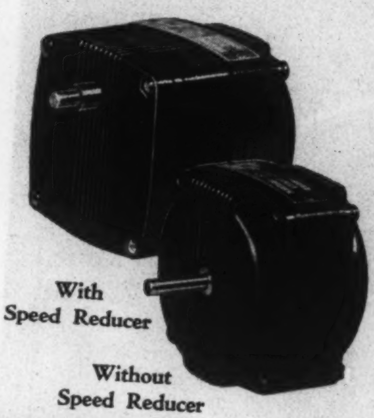
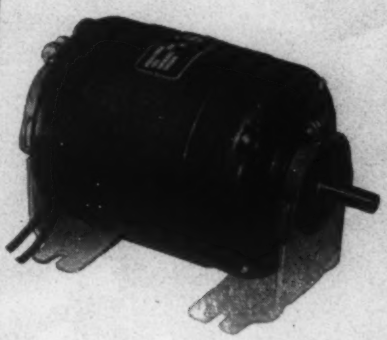


TYPE K MOTOR

Without speed reducer: Normal 60-cycle output ranges from 1/2000 hp to 1/500 hp on continuous duty. With speed reducer: Drive-shaft speeds ranging from 300 rpm to 1 rpm and with torque ratings of 1.3 in. oz to 110 in. oz, respectively. The Type K motor (which is 2⅜" high) is especially adapted to use on instruments and timing devices.



TYPE U MOTOR

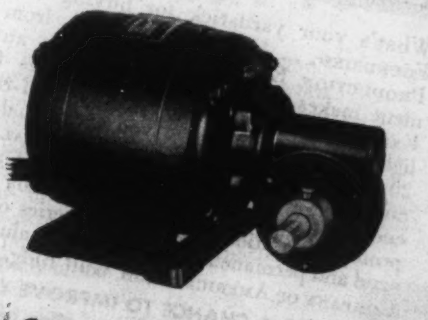
Available in 1/20 and 1/15 hp, at 1725 rpm, and 1/30 hp, at 1125 rpm. Diameter 4⅜". Split-phase construction. Resilient mounting for quiet operation. Thermal overload protection. For use in office machines, automatic phonographs, circulating pumps, air-conditioning equipment. Available only in standard construction and on quantity orders. Attractively priced. Rapid delivery on all orders.

SERIES WOUND MOTOR PARTS

SET includes: Field core and coil assembly, armature, brushes and associated parts, and fan. SIZE: Diameters to 3¾". Wound to order for all fractional horsepower ratings. APPLICATION: Portable power tools and appliances.

REDUCER MOTORS

Group 4: Double worm-gear reducer for transmitting high torques at low speeds. Height, 6⅞".



Group 3: Single-reduction, worm-gear reducer, designed for transmitting moderate torques. Height, 4⅞".

Group 2: Designed to deliver moderate torques. Height, 4¾".

Group 1: Designed to transmit low torques. Height, 3⅝".

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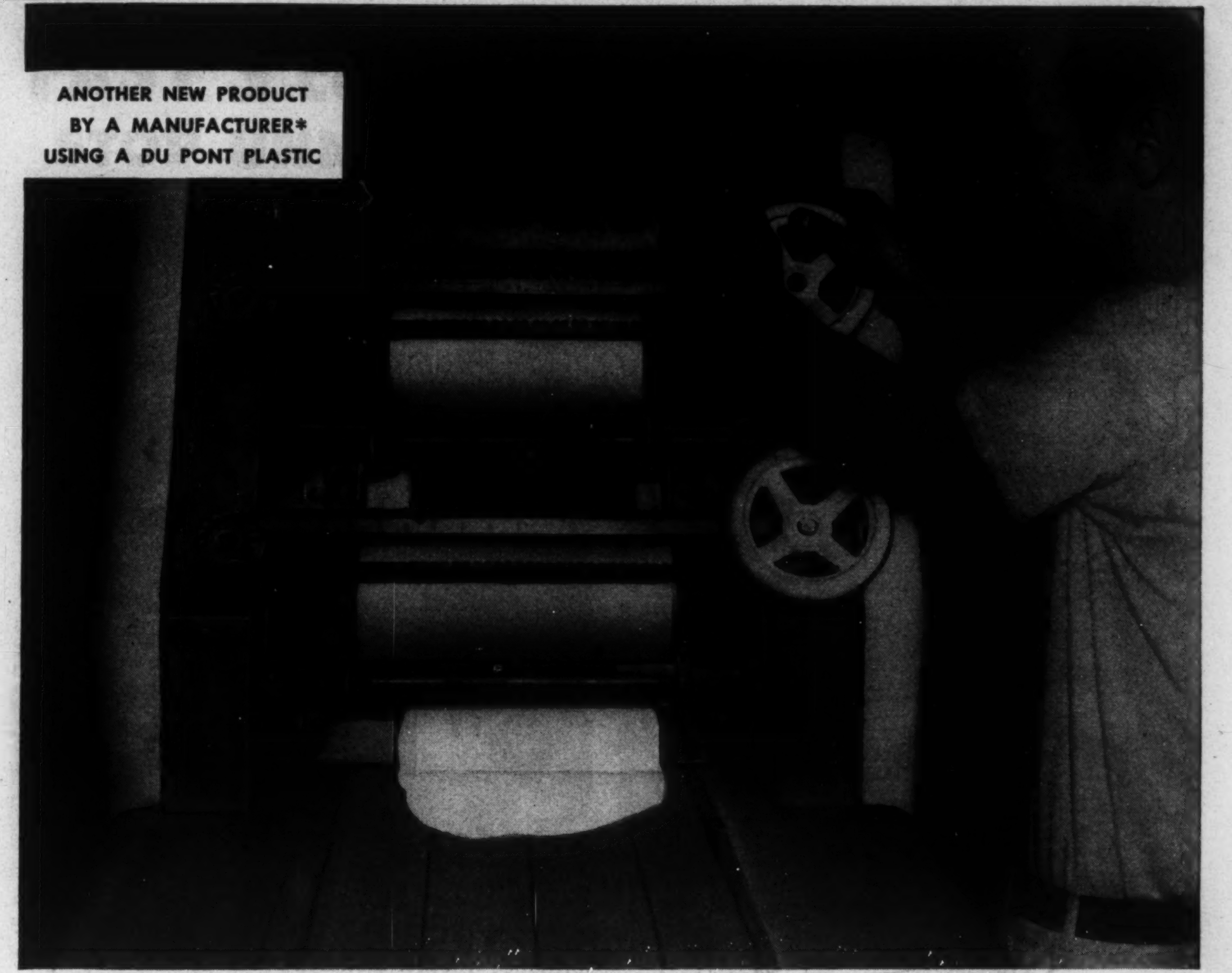

"TEFLON" ROLLS DOUGH WITHOUT STICKING—SAVES UP TO $20 A DAY PER MACHINE

WHAT'S NEW. The faces of this new home heat-sealer for frozen food packages are covered with a tough, thin film of highly heat-resistant Du Pont "Teflon." It makes home packaging easier because the "Teflon" cover prevents sticking of the faces on the sealer to plastic films used in home packaging of frozen foods. Made by The Dobeckmun Company, Cleveland, Ohio.

Nothing sticks to Du Pont "Teflon" tetrafluoroethylene resin . . . not even sticky dough. That's why bakers use bread sheeting rolls covered with a ½-inch layer of "Teflon." Unlike other types, these rolls don't pick up dough—need no flour dusting or scraping. Bakeries save as much as $20 a day on a single machine by the elimination of dusting flour alone.

In addition, rolls covered with "Teflon" yield a thinner sheet than old-style steel rolls, yet won't tear the dough . . . give a smooth, uniform product.

"Teflon" is used in many operations involving the handling of sticky materials. But this is just one of its many types of uses. It's flexible, durable—the most highly heat-resistant and chemically inert of all commercial thermoplastics. It's supplied as sheets, rods, tubes, tape, and molding powder. Write for more data on "Teflon" and other Du Pont plastics. E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept. (Consolidation of Plastics Dept. and Ammonia Dept.), Plastics Sales Offices: 350 Fifth Ave., New York 1, N. Y.; 7 S. Dearborn St., Chicago, Ill.; 845 E. 60th St., Los Angeles 1, Calif.

**Rolls covered with "Teflon" used on bread moulder-panner manufactured by Stickelber & Sons, Inc., 1150 Southwest Boulevard, Kansas City, Kansas.*

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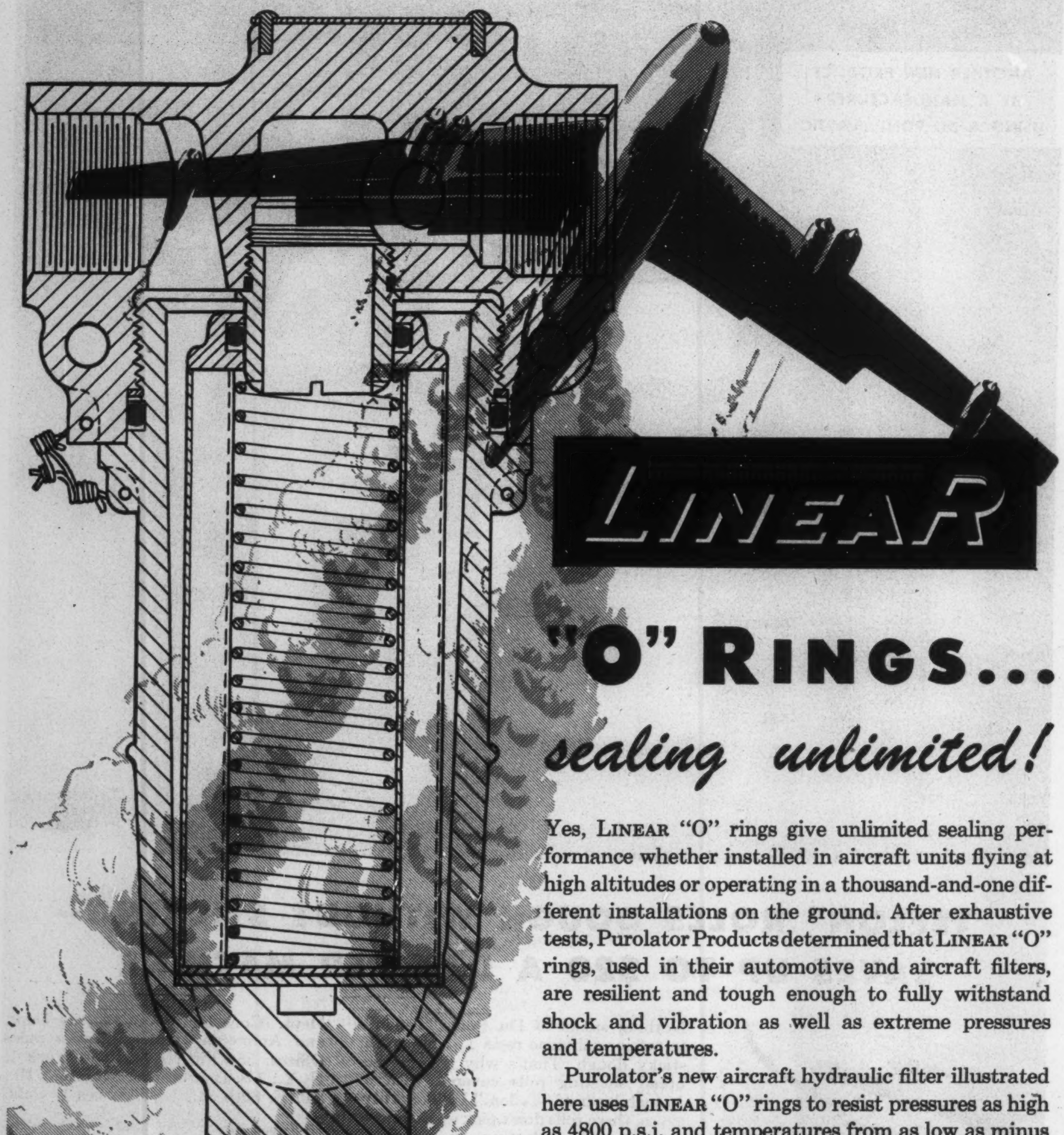
Plastics
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY



"O" RINGS...

sealing unlimited!

Yes, LINEAR "O" rings give unlimited sealing performance whether installed in aircraft units flying at high altitudes or operating in a thousand-and-one different installations on the ground. After exhaustive tests, Purolator Products determined that LINEAR "O" rings, used in their automotive and aircraft filters, are resilient and tough enough to fully withstand shock and vibration as well as extreme pressures and temperatures.

Purolator's new aircraft hydraulic filter illustrated here uses LINEAR "O" rings to resist pressures as high as 4800 p.s.i. and temperatures from as low as minus 68°F. to as high as plus 280°F. Purolator's experience is a good example of the versatility, reliability and simplicity effected with LINEAR "O" rings.

In addition to a long list of natural or synthetic rubber compounds adaptable to a wide range of temperatures, gases and liquids, LINEAR is successfully moulding "O," "V," "U" or other shapes of Kel-F, Teflon and Silicone for special applications. These special materials are suitable for seals from minus 320°F. to plus 400°F. against concentrated sulfuric, hydrofluoric, hydrochloric and other vigorous oxidizing materials.

For your individual packing design or application, CALL LINEAR.

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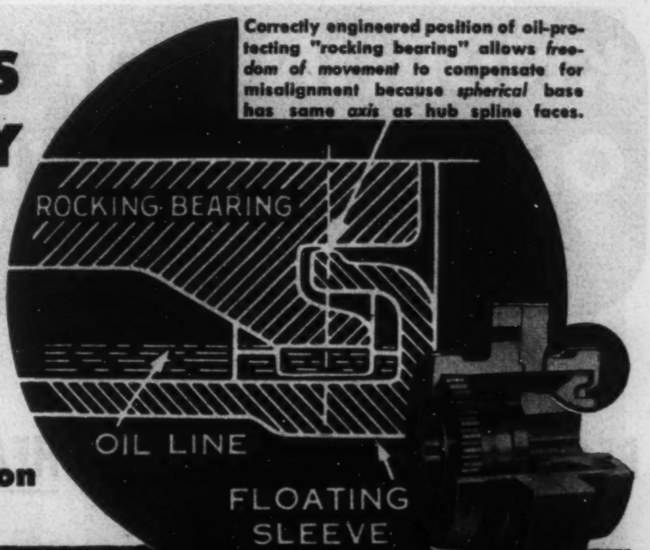
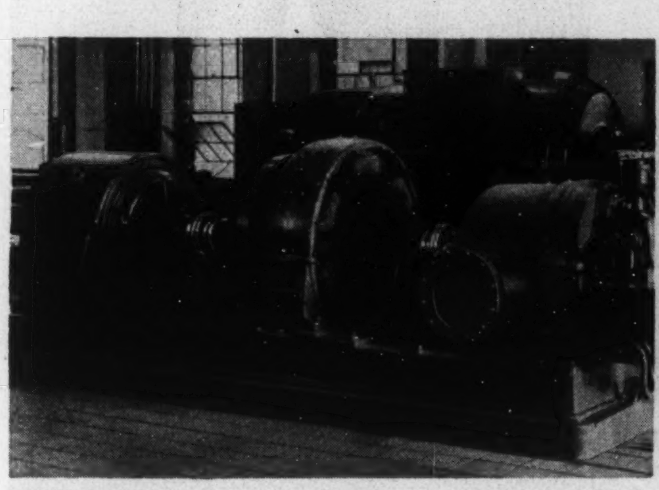
FAST'S COUPLINGS STOP UNNECESSARY SHUTDOWNS IN *Your* PLANT

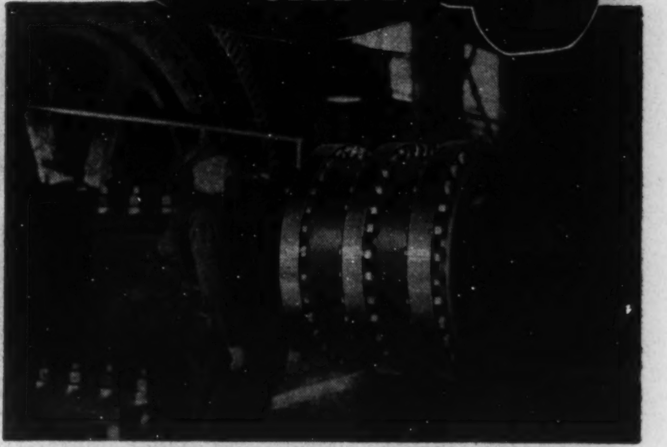
Exclusive Metal-to-Metal Seal And No Perishable Parts Give Uninterrupted Power Transmission



Correctly engineered position of oil-protecting "rocking bearing" allows freedom of movement to compensate for misalignment because *spherical* base has same *axis* as hub spline faces.



POWER PLANTS use Fast's Couplings because metal-to-metal seal, absence of perishable parts, virtually eliminate shutdowns!



STEEL MILLS specify Fast's Couplings for equipment of every shaft size to avoid production shutdowns caused by *failure* of ordinary couplings! This Coupling has been in use since 1923!

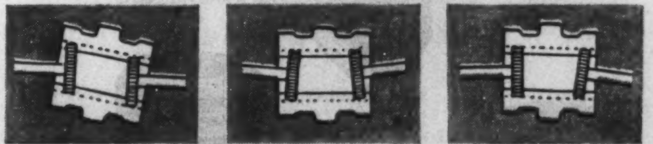
FAST'S Couplings virtually eliminate plant shutdowns because Fast's exclusive metal-to-metal seal gives positive protection, provides uninterrupted power transmission! Complete flexibility to compensate for shaft misalignment is done mechanically. Load-carrying oil is *completely* guarded by exclusive "rocking bearing" that keeps out dirt, grit and moisture without perishable packing rings! Nothing to wear! Nothing to replace! Result: Uninterrupted power transmission for all your installations!

Fast's complete line of Couplings is available right from stock from distribution points coast-to-coast. All Fast's Couplings are backed by years of top engineering experience, Koppers' high standard of workmanship, and unexcelled coupling service including available parts if required by change of drive, *even if your Fast's have been running for 30 years!* Fast's installed on your equipment mean longer machine and motor life, lower upkeep costs, minimum shutdown losses. Write today or use the handy coupon and get all the facts in the new Fast's Catalog. Address: KOPPERS CO., INC., FAST'S COUPLING DEPT., 352 Scott Street, Baltimore 3, Maryland.

Compensate for all Misalignment

The floating sleeve takes a neutral position. All forms of misalignment are compensated for between the lubricated faces of the splines, equally divided between driving and driven members. The entire assembly revolves as one unit.

The exaggerated diagrams below demonstrate this Fast's principle



FAST'S *Self-Aligning* COUPLINGS

KOPPERS

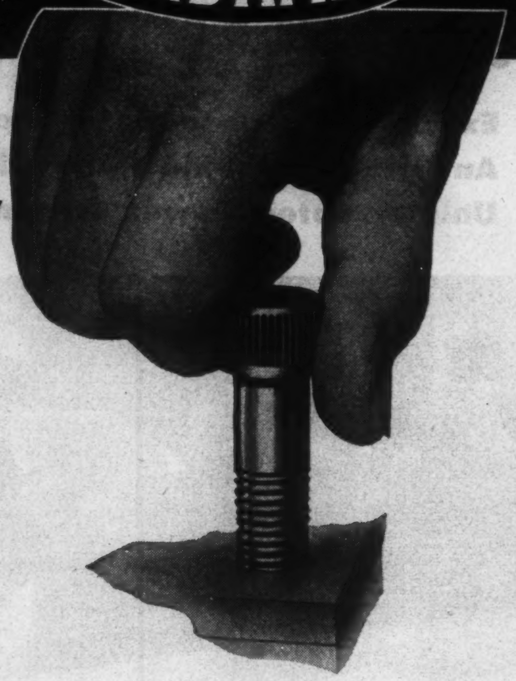
MAIL FREE CATALOG COUPON TODAY!

KOPPERS CO., INC., Fast's Coupling Dept.,
352 Scott Street, Baltimore 3, Md.

Please send me your Fast's Coupling catalog No. 47 which contains all the facts and specifications.

Name.................................Title..................
Company..
Address..
City..............................Zone......State..........

KNURLING OF SOCKET SCREWS ORIGINATED WITH UNBRAKO IN 1934



BECAUSE OF THEIR KNURLED HEADS,

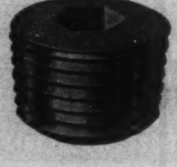
UNBRAKO

SOCKET HEAD CAP SCREWS SCREW IN *FASTER* AND *FURTHER* BEFORE A WRENCH BECOMES NECESSARY

There is a definite saving of assembly time when you use "UNBRAKO" Socket Head Cap Screws with Knurled Heads. The exclusive knurled heads perform triple duty: (1) *knurling* provides a sure, slip-proof grip; (2) *knurling* permits positive locking—a feature so often essential where there is excessive impact or vibration; (3) *knurling* speeds assembly, because it enables the "UNBRAKO" to be screwed in faster and further with the fingers—handiest of all wrenches—before a "key" becomes necessary.

As always, the brand name "UNBRAKO" signifies *great strength* and *precision manufacture to close tolerances*. "UNBRAKO" Knurled Socket Head Cap Screws are available in sizes from #4 to 1" diameter, in a full range of lengths. Other sizes to special order. Write for your copy of the "UNBRAKO" Catalog.

SELF-LOCKING "UNBRAKO" SOCKET SET SCREW WITH KNURLED THREADS PAT'D AND PATS. PEND.

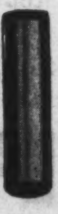


"UNBRAKO" FULLY-FORMED PRESSURE PLUG

SELF-LOCKING "UNBRAKO" SOCKET SET SCREW WITH KNURLED CUP POINT PAT'D

SELF-LOCKING "UNBRAKO" SQUARE HEAD SET SCREW WITH KNURLED POINT PAT'D AND PATS. PEND.

"UNBRAKO" SOCKET HEAD STRIPPER BOLT WITH KNURLED HEAD



"UNBRAKO" PRECISION-GROUND DOWEL PIN

SPS STANDARD PRESSED STEEL CO.

BOX 102, JENKINTOWN, PENNSYLVANIA

"Serving Industry continuously since 1903 through Industrial Distributors"

Maybe Bellows Assemblies are what you need, too!

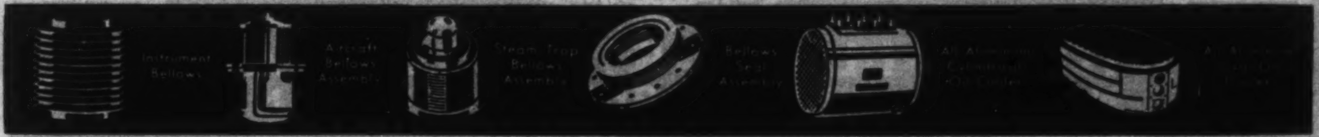
Temperature control instruments that make travel on passenger trains safer and more comfortable rely for accurate, dependable performance on Clifford Thermostatic Bellows Assemblies designed especially for the job to be done.

Whether your problem is controlling temperature or pressure, sealing shafts or valves against leakage, or transmitting motion, it may pay you to investigate bellows assemblies. Doing it before your designs are too far advanced may save you time, trouble and money. Our engineering department will make a confidential analysis of your sketches and specifications and submit recommendations. No cost or obligation involved. **CLIFFORD MANUFACTURING COMPANY,** 124 Grove St., Waltham 54, Massachusetts. *Division of Standard-Thomson Corporation.* Offices in New York, Detroit, Chicago, Los Angeles.

CLIFFORD

HYDRAULICALLY-FORMED BELLOWS AND BELLOWS ASSEMBLIES

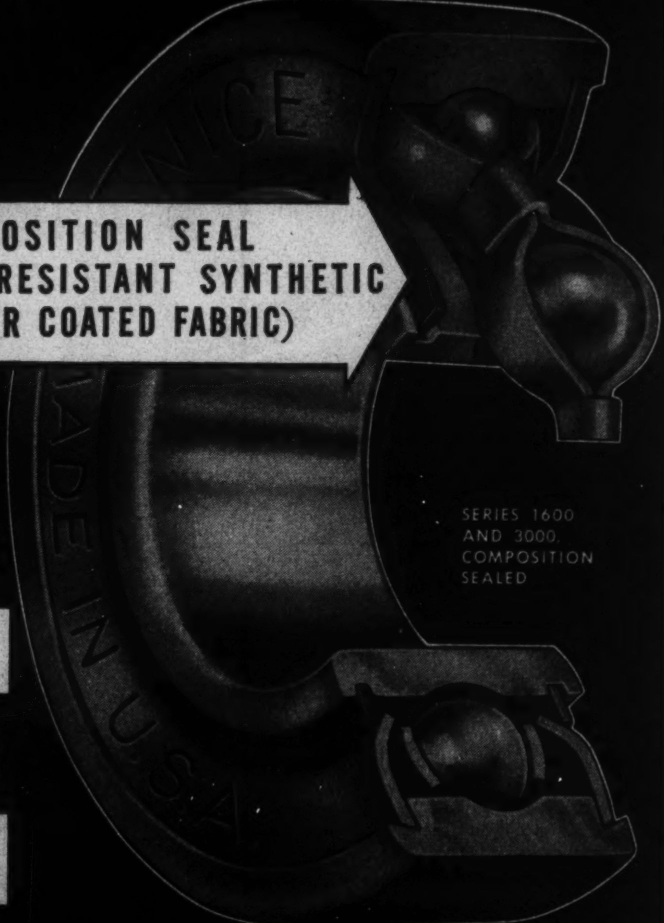
ALL-ALUMINUM OIL COOLERS FOR AIRCRAFT ENGINES


Instrument Bellows
Aircraft Bellows Assembly
Steam Trap Bellows Assembly
Bellows Seal Assembly
All-Aluminum Cylindrical Oil Cooler

Announcing!

Composition Sealed Bearings by

NICE



COMPOSITION SEAL
(OIL RESISTANT SYNTHETIC
RUBBER COATED FABRIC)

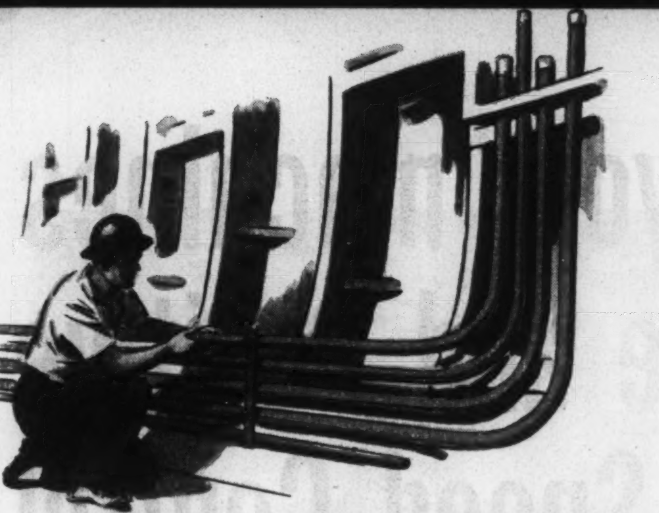
SERIES 1600
AND 3000
COMPOSITION
SEALED

Exhaustively field tested and proven highly successful, the NICE composition seal design effectively retains lubricant and excludes foreign material. Thus, NICE has added the performance advantage of an efficient seal to the already basic advantage of a quality bearing at comparative low cost.

Write for
New Catalog
No. 140

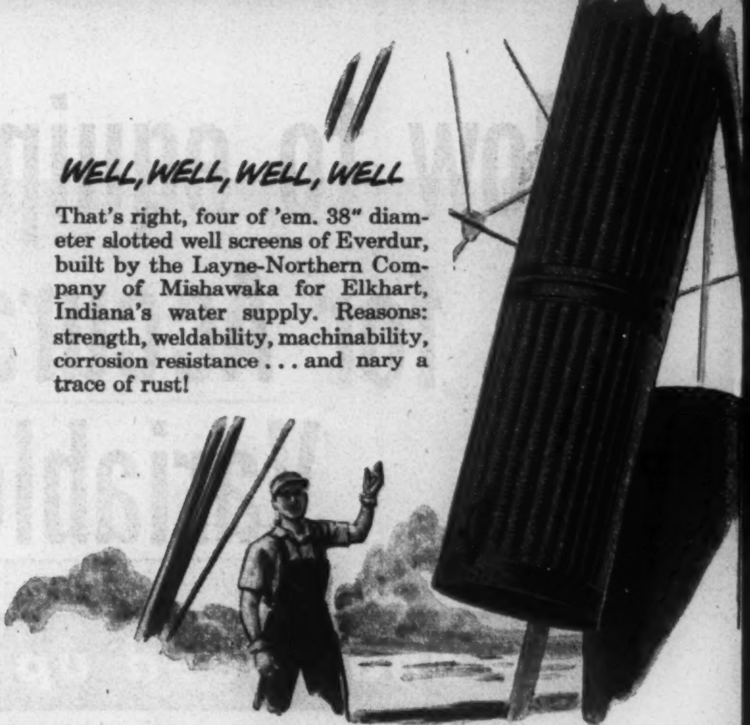
NICE

NICE BALL BEARING COMPANY
NICETOWN · PHILADELPHIA · PENNSYLVANIA



NO PLACE FOR REPLACEMENTS HERE!

. . . so the nation's biggest underwater tunnel uses Everdur† Electrical Conduit to carry traffic light and control cables. New York's Triborough Bridge and Tunnel Authority, builders of the Brooklyn-Battery Tunnel, made selection on the basis of long-time service records on comparable installations.

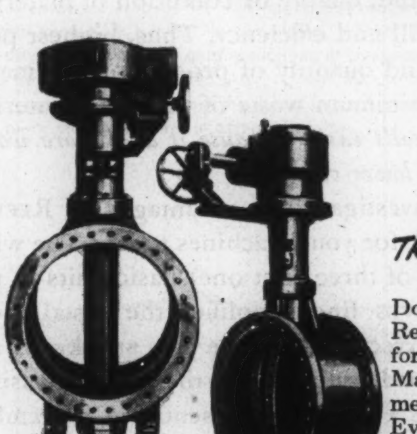


WELL, WELL, WELL, WELL

That's right, four of 'em. 38" diameter slotted well screens of Everdur, built by the Layne-Northern Company of Mishawaka for Elkhart, Indiana's water supply. Reasons: strength, weldability, machinability, corrosion resistance . . . and nary a trace of rust!

Watching EVERDUR* At Work

†REG. U. S. PAT. OFF.



TRAFFIC CONTROLS

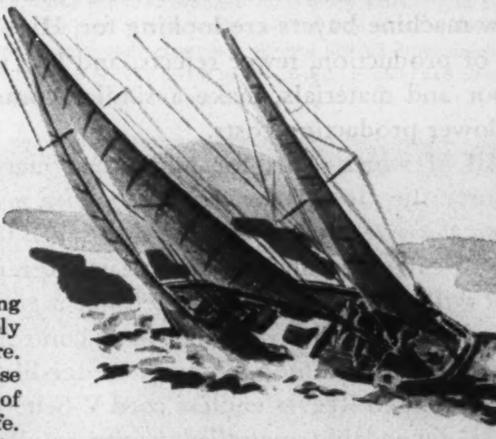
Down from the Alvarado Regulating Reservoir rushes the water supply for San Diego at 100-lb. pressure. Many of the vital parts of these mechanical traffic cops are made of Everdur for long operating life. These big butterfly valves, up to 42" I. D., were made by Coldwell-Wilcox Division of Krajewski-Pesant, New York.

"DID YOU KNOW" DEPARTMENT

Maybe it never occurred to you that many belt-drive applications require a non-magnetic, spark-resistant lacing. Well, they do. And the Flexible Steel Lacing Company of Chicago makes 'em under the trade name "Alligator." Out of Everdur, of course.

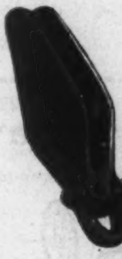
WHAT'S YOUR METAL PROBLEM?

Maybe Everdur can help. Our Technical Department is always ready to serve. Just write to The American Brass Company, Waterbury 88, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.



HAPPY THOUGHT IN A SQUALL!

When thunderheads race up and your boat lays over on her beam's end — you pray everything will hang together. That's the time to be thankful for your boat builder's judgment in using strong, tough, non-rust Everdur fastenings



. . . and speaking of seagoing metals, the Design Engineering Company of South Pasadena, California, developed this marine shell block of Everdur. Maximum strength and minimum weight are combined in this one-piece, folded-and-drawn, rivetless block construction. 49190

P.S. HOW ABOUT SENDING IN YOUR STORY ON EVERDUR?

Where corrosion resistance counts

ANACONDA

COPPER-SILICON ALLOYS*

How to equip your machines for Accurate and Positive Variable Speed Control

—and speed up your machine sales

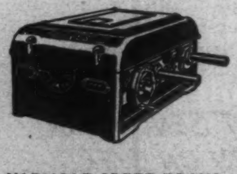
Increased output, even as much as 25%, so frequently obtained with REEVES Speed Control, is not all that new machine buyers are looking for. Higher quality of production, fewer rejects, and less waste of labor and materials, make a similar contribution to lower production costs.

All of which calls for more than mere speed adjustability. It calls for *accurate, positive, non-fluctuating power transmission,* at the best speed for every job. It calls for infinitely variable speed regulation that will not budge from its setting, regardless of speed or load—the variable speed control that is attained with the non-slipping, wedge-like action of the rugged REEVES endless cord V-belt, that provides dependably *controlled tension* at all driving speeds.

When machine speeds can be adjusted, instantly and positively, without stopping the machine, as with REEVES Speed Control, the operator can fit the speed to the job, to any change in operating conditions, to the kind, quality or condition of material, to his own skill and efficiency. Thus, highest possible quality and quantity of production are maintained, with minimum waste of time and material. *The machine sells easier because it does more work, better work, at lower cost.*

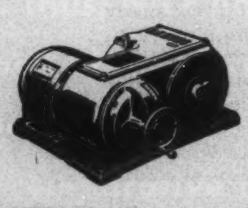
Why not investigate the advantages of REEVES Speed Control, for your machines today? The wide range of sizes of three (not one) basic units in the complete REEVES line simplifies the installation, insures the correct unit for the job, and keeps the cost for standard equipment at the lowest possible figure. There's a REEVES representative, a member of our nation-wide staff of speed control engineers, in your city or vicinity. He will be glad to discuss all of these details with you, at your convenience, and entirely without obligation on your part. Send for new catalog No. H26-3N, just off the press.

The Three Basic Reeves Units



VARIABLE SPEED TRANSMISSION for providing infinite, accurate speed flexibility over a wide range—2:1 to 16:1. Sizes—fractional to 87 hp.

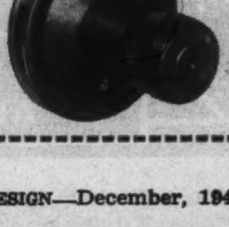
VARI-SPEED MOTOR PULLEY provides an instantly variable speed drive within 4:1 ratio for any constant speed motor. Sizes to 10 hp.

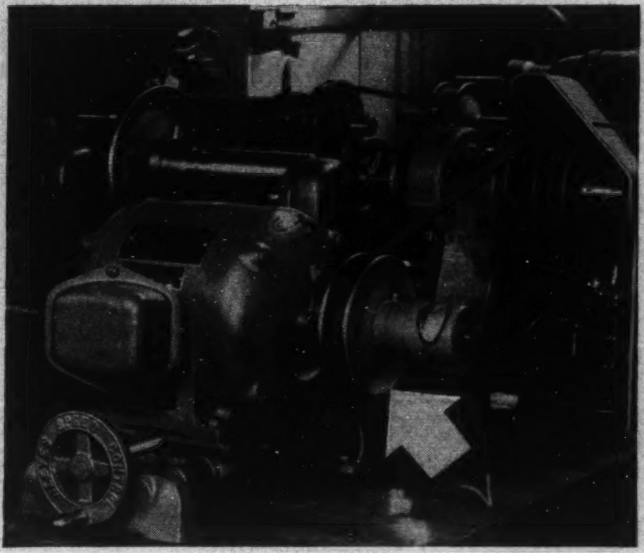


MOTODRIVE combines motor, speed varying mechanism and reduction gears in single unit. Speed variations 2:1 to 6:1 inclusive. Sizes to 20 hp.

And Now a "Junior" REEVES for Lightest Machines

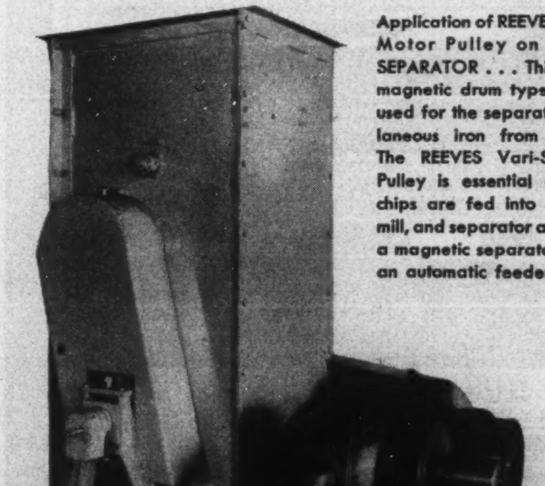
The latest member of the REEVES "family" of variable speed control units. Simplified, low cost unit is ideal for light duty lathes, saws, grinders, drill presses, pumps, etc. Forms actual driving element between motor and driven machine. Provides the right speed for every operation. Covers the entire speed range smoothly, without jumps or steps, without stopping the machine. Easy to apply—easy to use—uses any standard constant speed motor, any standard V-belt. Ask for Bulletin V-4912.





Application of new Vari-Speed Jr. unit on a dynamic balancing machine. In this particular instance the Vari-Speed unit replaced a step-cone pulley so that by simply turning the handwheel, without stopping the machine, the driving speed can be quickly changed to compensate for different sizes and weights of pieces tested. Also, through the use of this variable speed drive, the operator can check the pieces being tested under all speeds that the piece might encounter in actual operation.

Application of REEVES Variable Speed Transmission on a Heavy Duty Turning Roll. These machines are used for rotating extremely large and heavy vessels, for manual or automatic welding. Size of vessel determines rotating speed, accurately controlled with the REEVES Transmission. Unit shown is a No. O-B REEVES giving an 8:1 speed variation and operating speed ranging from 5″ to 40″ per minute.



Application of REEVES Vari-Speed Motor Pulley on MAGNETIC SEPARATOR . . . This high power magnetic drum type separator is used for the separation of miscellaneous iron from wood chips. The REEVES Vari-Speed Motor Pulley is essential as the wood chips are fed into a pulverizing mill, and separator acts not only as a magnetic separator but also as an automatic feeder for the mill.

REEVES Motodrive with 5 H.P. explosion proof motor connected directly to a worm gear reducer to drive agitator at a speed between 26 and 130 rpm. This unit is a 500-gallon jacketed stainless steel kettle for use in preparation of penicillin.

REEVES PULLEY COMPANY • COLUMBUS, INDIANA

ACCURATE • VARIABLE

Reeves Speed Control

GIVES THE RIGHT SPEED FOR EVERY JOB!

Recognized Leader in the Specialized Field of Speed Control Engineering

8 outstanding N.B.M. BABBITTS

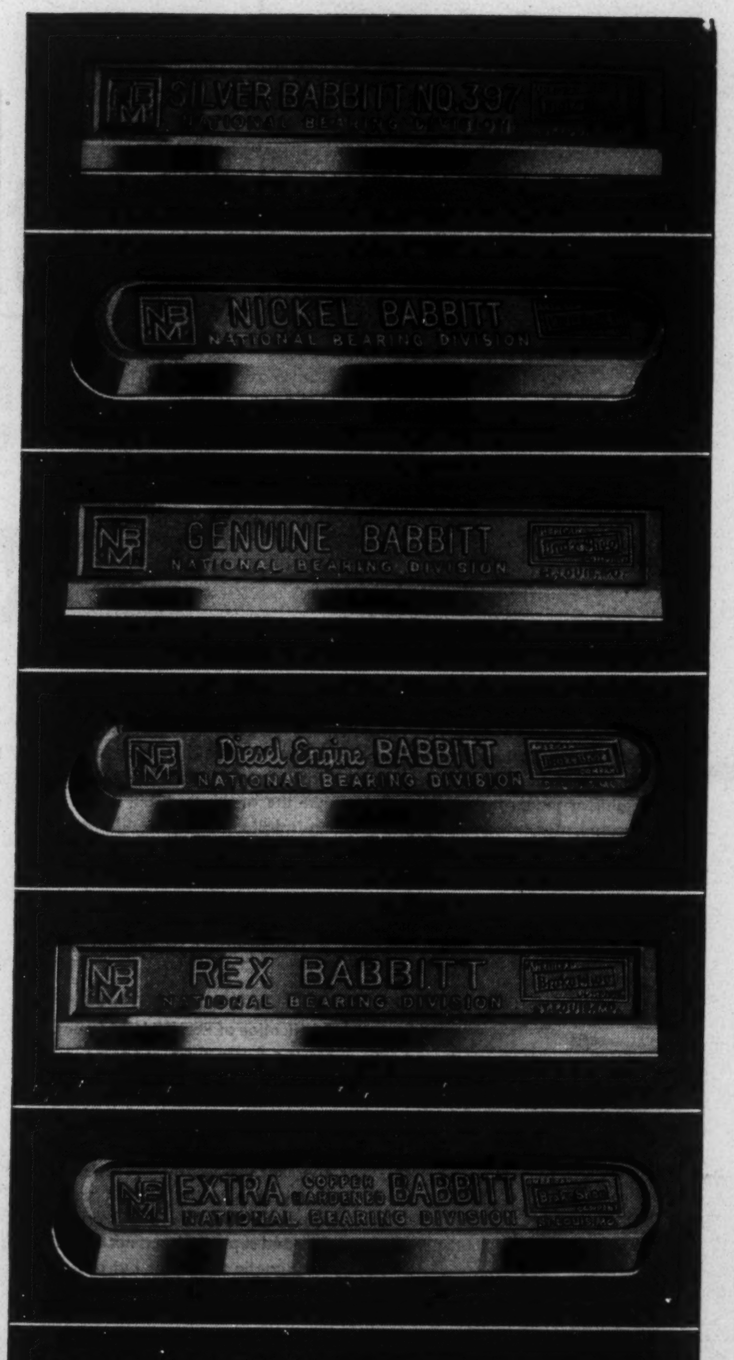
Help Give You Better Bearing Performance . . . Longer Bearing Life

Good babbitt is the result of using Virgin Metals, correctly proportioned and blended under close laboratory control. You find *all* these qualities in N-B-M Babbitts.

The 8 N-B-M Babbitt Metals shown are the result of years of research combined with actual engineering analysis of all types of bearing lining problems. Each of these N-B-M Babbitt Metals is "custom-alloyed" for specific types of service conditions. Thus, each has definite advantages over so-called "all-purpose" babbitts—advantages that result in longer, more economical bearing service.

These "Custom-Alloyed" bearing lining metals have effected important savings in plant maintenance—and big improvements in product performance. Every Product Designer or Plant Engineer should have engineering data on the complete line of these better N-B-M Babbitt Metals.

Here is Complete Data on N-B-M Babbitt Metals . . . This folder describes all 8 N-B-M Babbitt Metals, giving data on application, physical properties, preparation of bearing shells and pouring. Write for your free copy!


NBM SILVER BABBITT NO.397
NATIONAL BEARING DIVISION
NBM NICKEL BABBITT
NATIONAL BEARING DIVISION
NBM GENUINE BABBITT
NATIONAL BEARING DIVISION
Brake Shoe
NBM Diesel Engine BABBITT
NATIONAL BEARING DIVISION
NBM REX BABBITT
NATIONAL BEARING DIVISION
Brake Shoe
NBM EXTRA COPPER HARDENED BABBITT
NATIONAL BEARING DIVISION
NBM REGENT BABBITT
NATIONAL BEARING DIVISION
Brake Shoe
ST. LOUIS MO.
NBM IMPROVED BABBITT
NATIONAL BEARING DIVISION

NBM

AMERICAN
Brake Shoe
COMPANY

NATIONAL BEARING DIVISION
ST. LOUIS 10, MO. • MEADVILLE, PA.

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

Further Information?

IF YOU DESIRE MORE INFORMATION ON ANY ADVERTISEMENT IN THIS ISSUE

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YOUR NAME ____________________ TITLE ____________

COMPANY ____________________

ADDRESS ____________________

CITY ____________________ STATE ____________

MD12-49

FIRST CLASS
PERMIT No. 36
(Sec. 510 P.L.&R.)
Cleveland, Ohio

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

4c POSTAGE WILL BE PAID BY—

MACHINE DESIGN
Penton Building
Cleveland 13, Ohio

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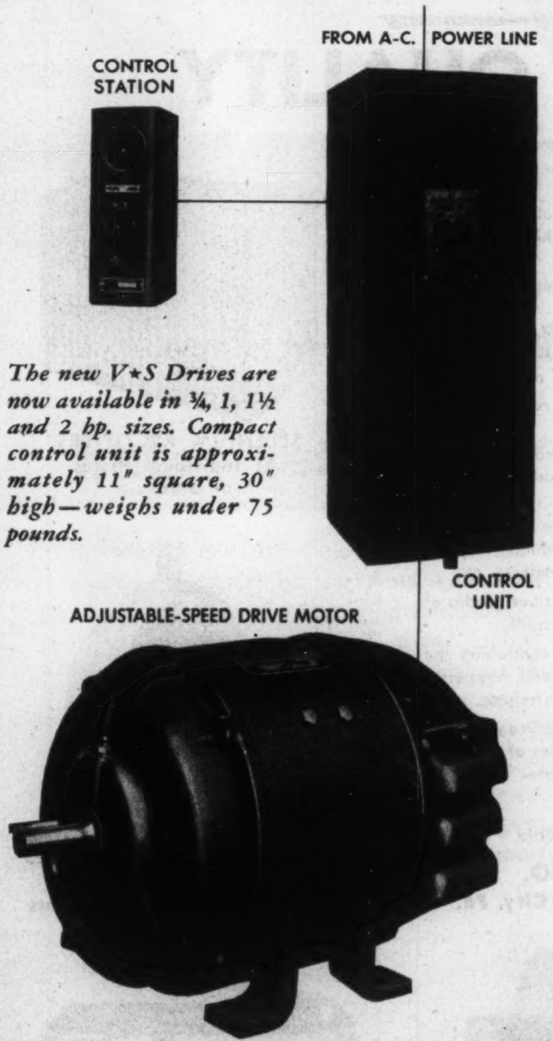
Wichita City Library

RELIANCE V★S DRIVE

NOW . . . NEW V★S DRIVES

(3/4-2 hp.)

for Thousands of Additional Applications



The new V★S Drives are now available in ¾, 1, 1½ and 2 hp. sizes. Compact control unit is approximately 11" square, 30" high—weighs under 75 pounds.

The Original Packaged All-Electric, Adjustable-Speed Drive for A-c. Circuits

at a price everybody can afford!

Adjustable Speeds from A-c. Power for GREATER PRODUCTION at LOWER COST!

Here is a simple, space-saving, low-cost *All-electric* Adjustable-speed Drive. This V★S Drive utilizes the same fundamental principles employed in the design of *all* Reliance V★S Drives for over 11 years.

UNLIMITED SPEED CHANGES. Provides an unlimited selection of speeds over a wide range—*electrically.*

JOGGING AND CREEPING SPEEDS. Selector switch provides for slow, jogging speed. Creeping speeds available through speed adjustor.

REMOTE CONTROL. Push a button and twist a knob—at the machine or at any remote location—for *instant* action.

QUICK, SMOOTH STARTING AND STOPPING. Offers fully controlled starting and stopping. Dynamic braking is available.

SPACE-SAVING. Compact, adjustable-speed drive motor connected to the driven machine saves valuable production space.

SIMPLIFIED DESIGN. Simplest design ever achieved in a packaged, all-electric adjustable-speed drive operating from A-c. circuits.

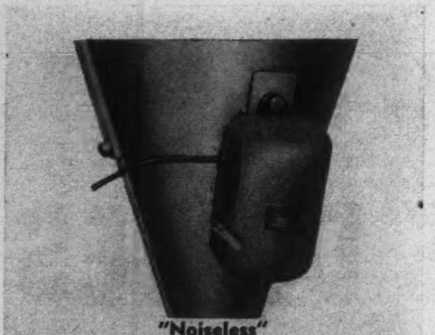
ADAPTABLE. The new V★S Drive can be easily applied to existing machines or built into machines as original equipment.

Machine builder or machine user, it will pay you to have all the facts on this important extension of the V★S line. Write today for Bulletin D-2101.

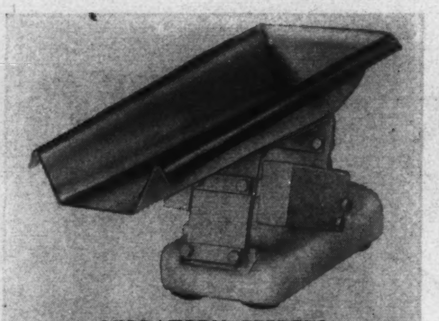
Sales Representatives in Principal Cities

RELIANCE ELECTRIC AND ENGINEERING CO.

"Motor-Drive is More Than Power" • [illegible] Road, Cleveland 10, Ohio



"Noiseless"
BIN VIBRATORS
Make Stubborn Materials Flow Freely



VIBRATORY FEEDERS
Finger-Tip Control of the Rate of Bulk Material Flow

VIBRATORY PACKERS
Pack and Settle Materials in Containers and Molds

USE COMPONENTS OF SYNTRON DEPENDABLE QUALITY

SMALL PARTS FEEDERS
Single Line Feed — Piece by Piece

SELENIUM RECTIFIERS
As Individual Plates or Stacks

ELECTRIC VIBRATORS, promoting free-flowing materials out of bins, hoppers and chutes.

VIBRATORY FEEDERS, controlling the flow of materials in packaging machines, batching systems, etc.

VIBRATORY PACKERS, settling materials in containers and in molds.

SMALL PARTS FEEDERS, feeding small objects to automatic machinery, inspection belts, counting and packaging machinery.

VIBRATING GRIZZLIES, for rough scalping and separation.

VIBRATING SCREENS, removing foreign objects, lumps, etc., from foods, chemicals, ceramics.

SHAFT SEALS to eliminate leakage of gases and liquids from around rotating shafts of compressors, pumps, mixers, etc.

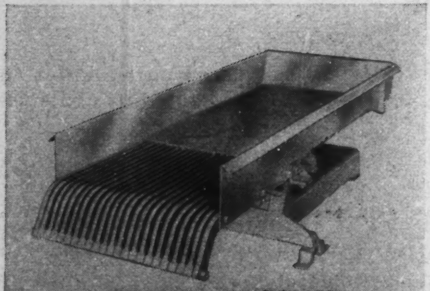
SCREW PUMPS, handling various grades of oil—crude, fuel, lube and hydraulic.

HOPPER LEVER SWITCHES, controlling the amount of material in bins and hoppers—controlling batch weighing by volume.

SELENIUM RECTIFIERS for efficent conversion of A.C. to D.C. in all types of electrical equipment. From 1" sq. plates up to 6" x 12".

Write for catalog data

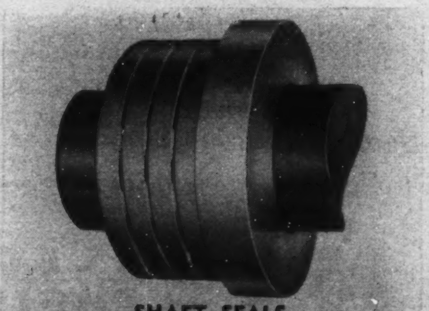
SYNTRON CO.
260 Lexington, Homer City, Pa.



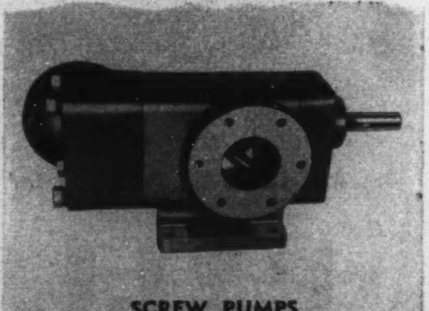
VIBRATING GRIZZLIES
Both Feed and Scalp With One Unit

HOPPER LEVEL SWITCHES
Control Maximum and Minimum Hopper Contents

VIBRATING SCREENS
Wet or Dry — Single or Multiple Decks



SHAFT SEALS
Replace Packing and Eliminate Leakage From Around Rotating Shafts



SCREW PUMPS
For Smooth, Pulseless Continuous Axial Flow

YOU CAN BE **SURE**.. IF IT'S

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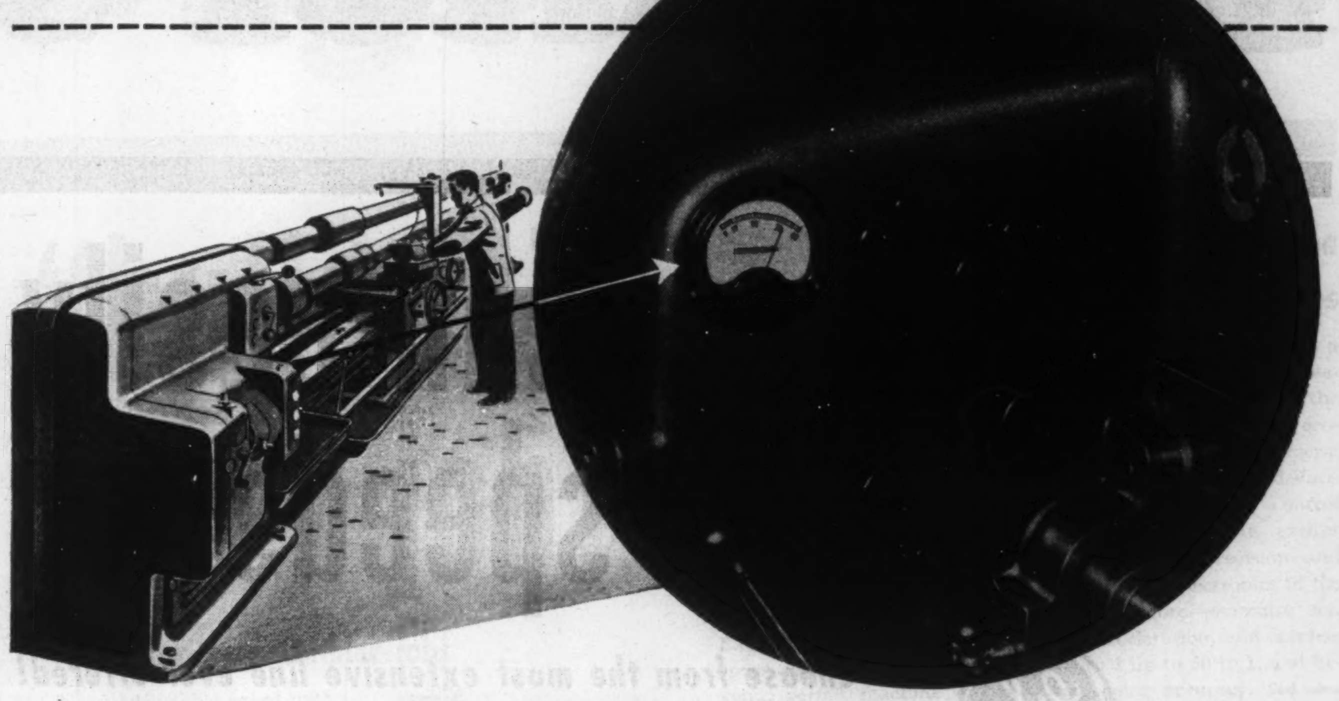

This Westinghouse Instrument helps set *New Production Records*

Savings in machine time up to 75% are common among the users of the American Tool Works Company's new hydraulic duplicating lathes!

A standard feature of these lathes is the Westinghouse horsepower instrument. It shows, at a glance, the horsepower being consumed by the cut. This enables the operator to take full advantage of the capabilities of the machine and to make maximum cuts without overloading. Machines can be easily operated at peak loads, without the dangers of overtaxed motors and damaged cutting tools.

This is another example of the application of Westinghouse instruments to *specific* problems. Westinghouse instruments are *engineered* and built to give you reliable performance in *every* application. The completeness of the line means electrical measuring instruments to fill *your* needs exactly in every field of industry.

Westinghouse instrument specialists are available in the field for consultation. Call your nearest Westinghouse office or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

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FOR *ANY* JOB

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Now you can easily the RIGHT speeds for

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PACKAGED ADJUSTABLE-SPEED DRIVES

adjustable SPEED
GENERAL ELECTRIC

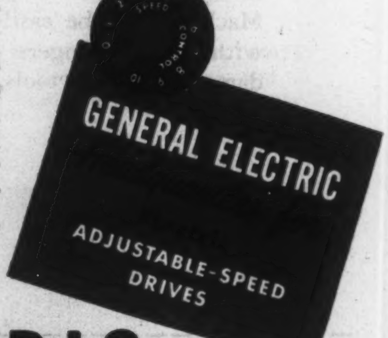
HERE'S HELP IN SELECTING THE DRIVES YOU NEED!

You'll find this new 26-page illustrated manual a gold mine of helpful information on the whole subject of adjustable speed. It describes the specific advantages that properly-applied adjustable speed has brought to various industries, and discusses points to be considered by designers in selecting adjustable-speed drives. It's yours for the asking! **Send for new Bulletin GEA-5334.**

Better control of drive speeds—through *electric* adjustable speed—is your key to making machines more productive, more versatile, more accurate. Now General Electric makes it easier for you to incorporate in your machines the electric adjustable-speed drives that will match your specific design needs. Here is the most comprehensive line of packaged adjustable-speed drives ever offered by one manufacturer!

All this and packaged too! These G-E adjustable-speed drives—made in pre-engineered "packages"—eliminate costly installation expense and delay. By providing optimum speeds, they enable machines to produce faster, process a greater variety of goods, turn out better and more uniform products with less wasted material. They're easy to operate and maintain, and because of their compactness and flexibility, they use only minimum space, whether "built-in" or mounted adjacent to the machine. This simplifies your customer's plant layout problem.

Just off the press is an all-new series of booklets on G-E adjustable-speed drives. We'll gladly send you copies. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*



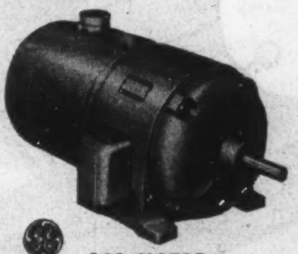
GENERAL ELECTRIC

Digest

PRODUCT HIGHLIGHTS

"build-in" every job!

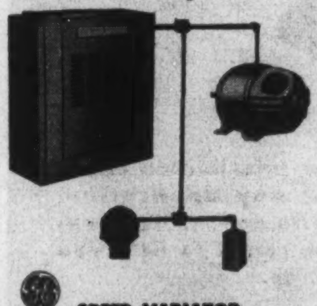
RIGHT for your simpler jobs



ACA MOTOR

Need adjustable speed with moderate regulation over a moderate speed range? The simplest, least expensive way to get it is with the General Electric Type ACA motor—plus standard control. A simple twist of a dial gives you stepless speed adjustment over ranges from 3 to 1 up to 20 to 1. A compact motor, it's built to standard NEMA dimensions to simplify installation. Ratings, in Tri-Clad construction, run from 3 to 75 hp. **See new Bulletin GEA-4883.**

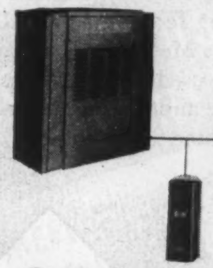
RIGHT for your intermediate needs



SPEED VARIATOR

For speed ranges up to 16 to 1 or more with good regulation and great flexibility, turn to the General Electric Speed Variator. It's mass-produced for price economy, yet built to meet your specific needs. Components are a d-c driving motor located at your machine, an operator's control station that can be put in any convenient location, and a "package" containing everything else—motor-generator set, exciter, and all control. This "package" can be either mounted directly on the machine or located remotely to save space at the machine. **See new Bulletin GEA-5335.**

RIGHT for precision speed control in the higher hp ranges

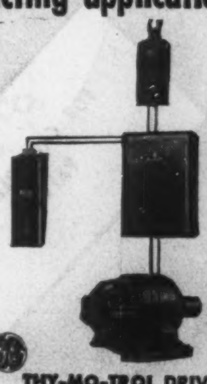


ELECTRONIC SPEED VARIATOR

If your machine requires a closely-regulated adjustable-speed drive to operate in the 15 to 60 hp range, the economical choice is the General Electric Electronic Speed Variator. An electronic control system replaces the exciter and adds the precision and versatility of electronics to the continuing economy and reliability of a motor-generator set. Excellent speed regulation, controlled acceleration, and stepless speed adjustment over ranges from 8 to 1 up to 50 to 1, and beyond, permit machine speeds of pin-point accuracy. **See new Bulletin GEA-5336.**

RIGHT for your most exacting applications

Most accurate, most versatile and fastest-acting of all General Electric packaged adjustable-speed drives is Thy-mo-trol®. This all-electronic system, in standard ratings from 1/40 to 30 hp, provides smooth, stepless speed control over ranges up to 100 to 1 and even beyond—can hold any set speed within ½ per cent or less regardless of changes in load or line voltage—offers almost endless combinations of standard and optional features for practically any application. **See new Bulletin GEA-5337.**



THY-MO-TROL DRIVE

General Electric Company, Section B668-78
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

- ☐ **GEA-4883—ACA motors**
- ☐ **GEA-5334—Adjustable-speed drives**
- ☐ **GEA-5335—Speed variator**
- ☐ **GEA-5336—Electronic speed variator**
- ☐ **GEA-5337—Thy-mo-trol drive**

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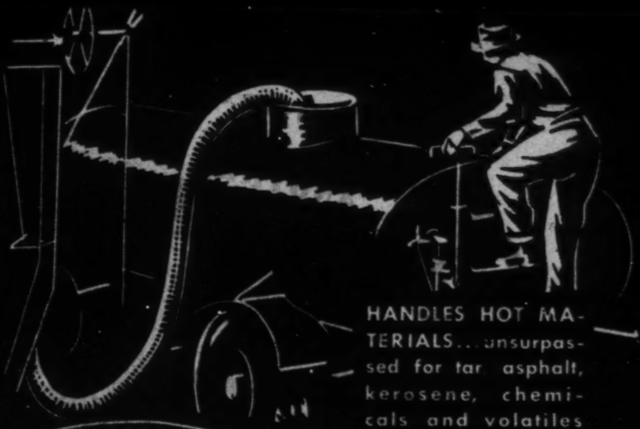

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FLEXIBLE METALLIC TUBING TO MEET EVERY SPECIFICATION OF THE DESIGN INDUSTRY

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Coast to coast . . . border to border, Penflex installations prove the value of "Flexineering"—the science of applying flexible tubing to fit the particular need of the design industry. When you require tubing or hose that is tight as a pipe but flexible, safe at high temperatures . . . free from metal fatigue . . . specify Penflex.

Penflex manufactures a complete line of 4 wall interlocked and seamless welded corrugated flexible tubing . . . plus automatic barrell fillers, rivet passers, accessories and fittings. Write for the folder for the design industry . . . "Flexineering."

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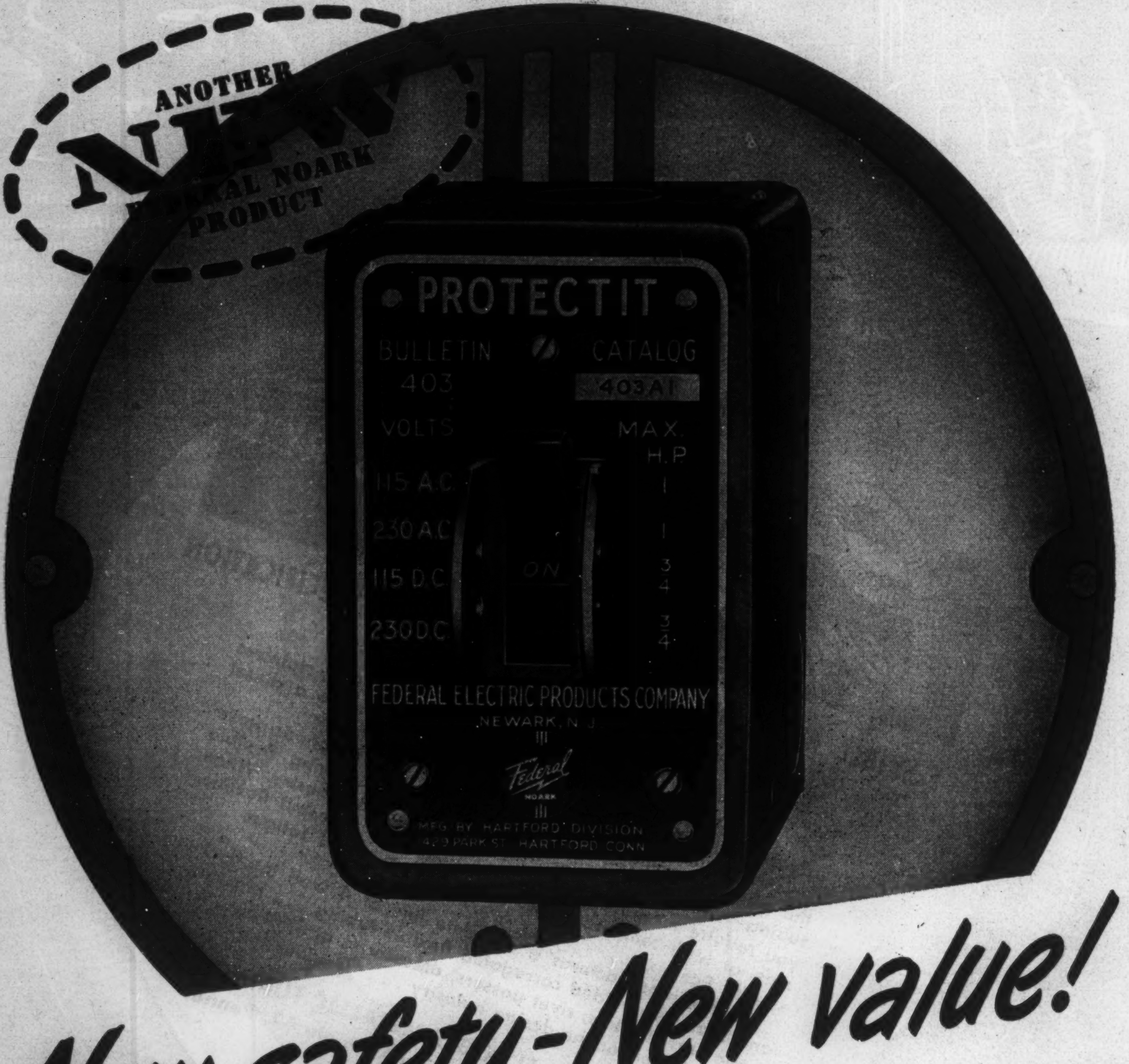
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New safety-New value!

New Federal Noark Protectit is today's outstanding fractional horsepower manual motor starter

THERE'S A WIDESPREAD NEED for small motor starters . . . and you'll meet it in a big way with the new Noark Protectit. This compact, modern device provides dependable automatic overload protection and is designed throughout for truly superior service.

The new Noark Protectit has double-break silver contacts welded to phosphor bronze contact springs. Reset after tripping is automatic. Individual arcing chambers confine each arc and assure rapid extinction. The bimetallic overload element is time-proven and accurate. Overload relay heaters are conveniently mounted from the front of the Protectit with a single screw.

New Noark Protectits are rated in 1 h.p., 115-230 V., single phase A. C., and in ¾ h.p., 115-230 V., D. C. Surface enclosure and open types; flush mounting Protectits using standard flush plate available. Order from your Federal Distributor. And have him send you a descriptive folder. Federal Electric Products Company, 50 Paris Street, Newark 5, New Jersey.

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Some of these grades are *new* . . . comparatively recent developments of our research and experience as a pioneer and leader in stainless steel production. Others are improved versions of older analyses. The latest information on the entire subject of stainless plates is available to you in the booklet illustrated above—32 pages of valuable data on types, sizes, finishes, fabricating methods and uses, including ASTM and ASME boiler codes.

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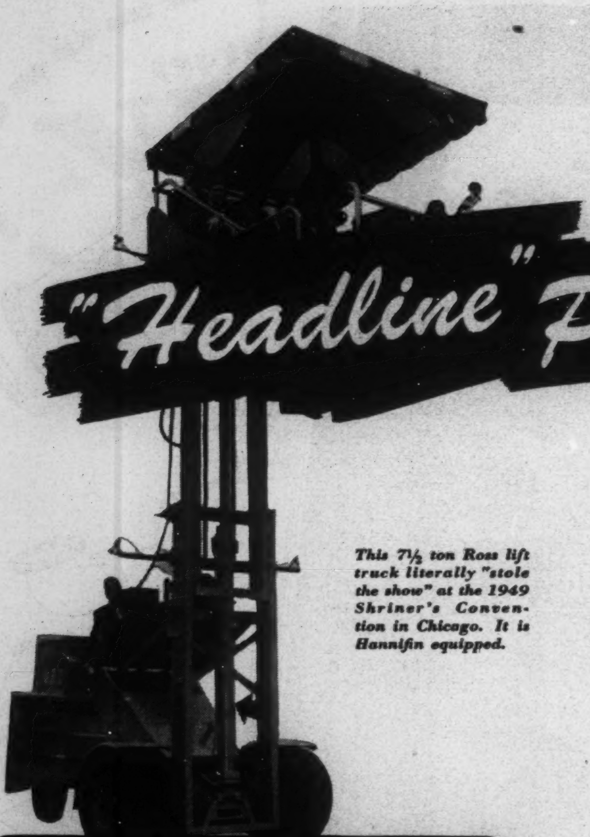

This 7½ ton Ross lift truck literally "stole the show" at the 1949 Shriner's Convention in Chicago. It is Hannifin equipped.

IT'S a *better* product when it's Hannifin equipped! Hannifin Hydraulic Cylinders are unexcelled for precision construction, precision performance. An improved type of high pressure cylinder, they are built especially to meet the requirements of makers of finest machine tools. Yet they are equally economical and practical for all kinds of applications where smooth, full-power performance and long-lasting, maintenance-free service are important. ASK FOR RECOMMENDATIONS.

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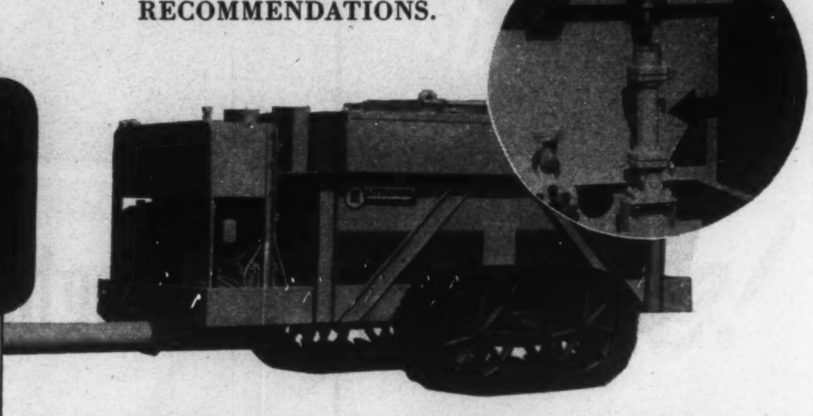
IMPROVED DESIGN. Universal end caps for easy installation and simplified piping. Full 4-ring piston construction; tight-sealing, honed, precision type. No tie rod design.

"TRU-BORED" AND HONED. Exclusive Hannifin long stroke honing process; satin finish. All parts interchangeable.

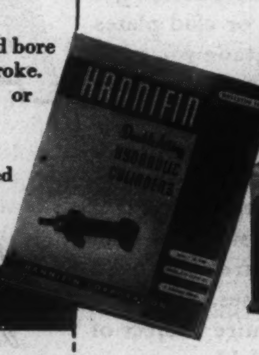
TYPES FOR EVERY PURPOSE. 12 standard bore diameters, 1" to 8". Any length stroke. 11 standard mounting styles. With or without cushions.

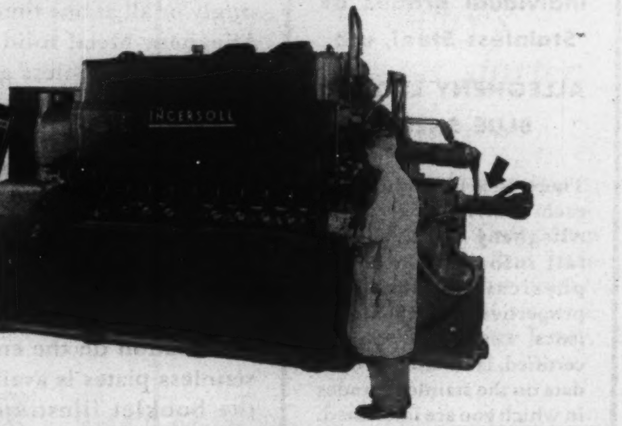
ENGINEERING RECOMMENDATIONS. Backed by more than forty years of leadership in the field.



It works while you "run"! The agitator in this batch trailer built by Littleford Bros., Cincinnati, Ohio, is operated by a Hannifin hydraulic cylinder to keep the mix from hardening until used.

"One machine does the work of TEN" describes this special Hannifin equipped 10 spindle milling machine built by The Ingersoll Milling Machine Co., Rockford, Ill.





INFORMATION

HANNIFIN CORPORATION
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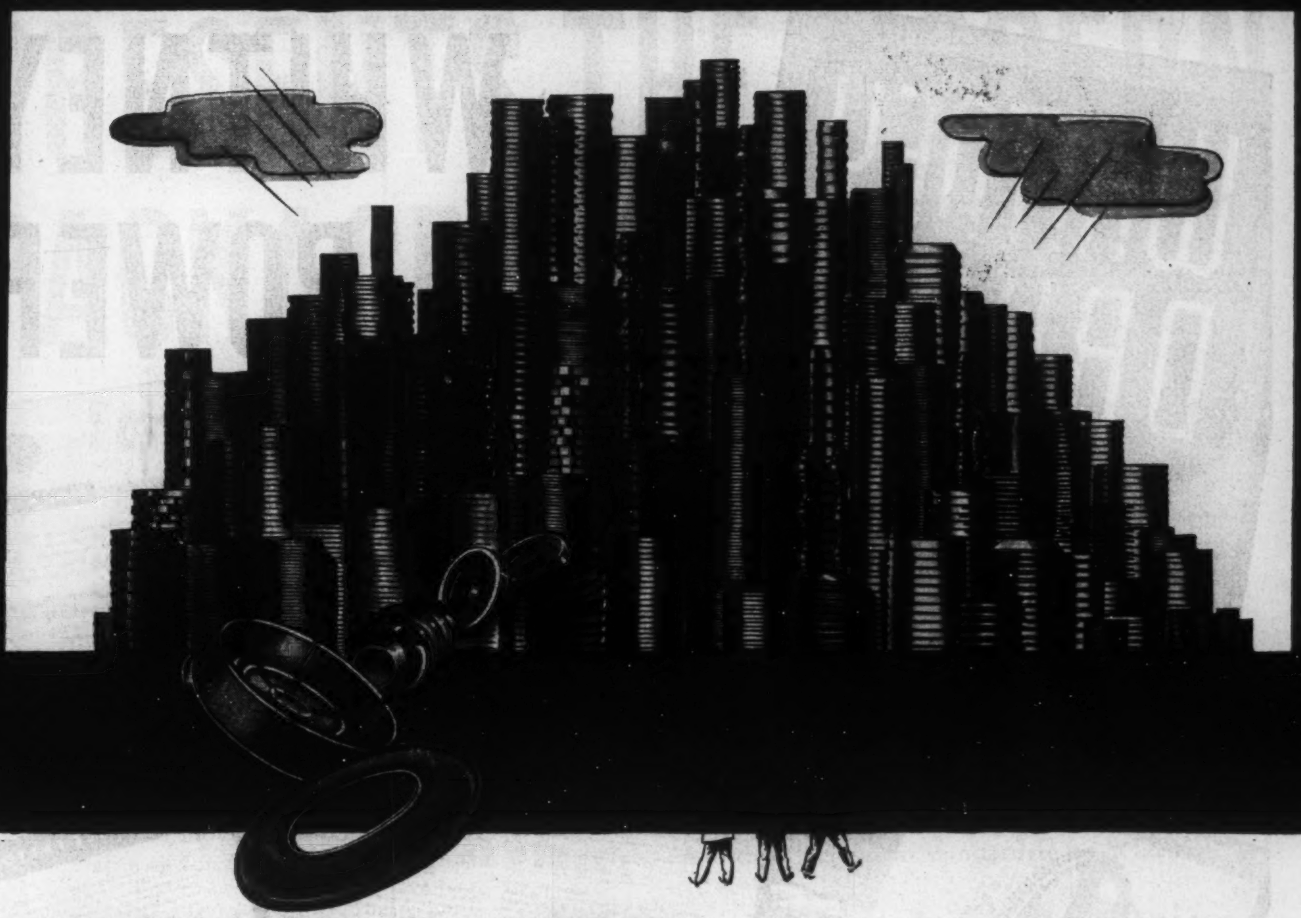

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Chances are the Sirvene part you order will be utterly unlike any other. For, while Chicago Rawhide produces literally tons of Sirvene in a year's time, every batch is earmarked for a different pliable part. Each of these parts is designed and developed to do just one special job in a particular mechanism. For every application, Sirvene engineers compound a special formula from pure, oil-resistant elastomers. From it, they mold a custom-engineered part which will fulfill specific requirements in tensile strength, elongation, elasticity or hardness, resilience, and resistance to dryness, moisture, temperature extremes and other deteriorating elements. As a result of laboratory-controlled production methods, Sirvene parts function under unusually severe conditions. That's why engineers across the country depend on Sirvene for their critical pliable parts. Sirvene engineers offer you their unlimited backlog of experience and research. Use it in solving your mechanical elastomer problems.

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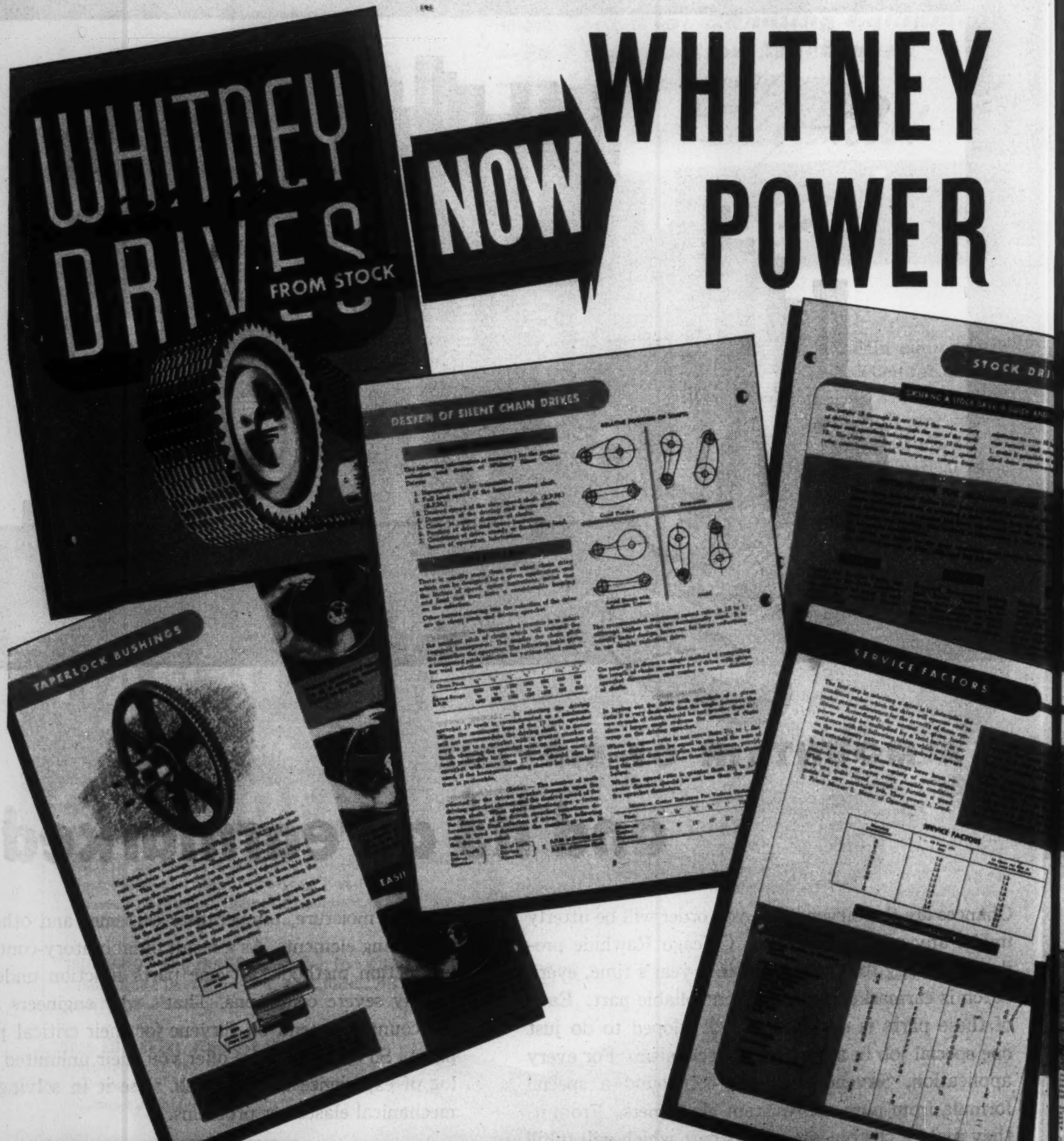
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For Economical, Efficient Power Transmission!

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Quick Selection of Correct Silent Chain Drive Made in 3 Easy Steps

1 Apply "Service Factor" to drive condition and obtain required Horsepower Rating!

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3 Under "Driven Speed" find nearest R.P.M. to driven speed required; table gives complete specifications and "Stock Drive No." of the chain drive!

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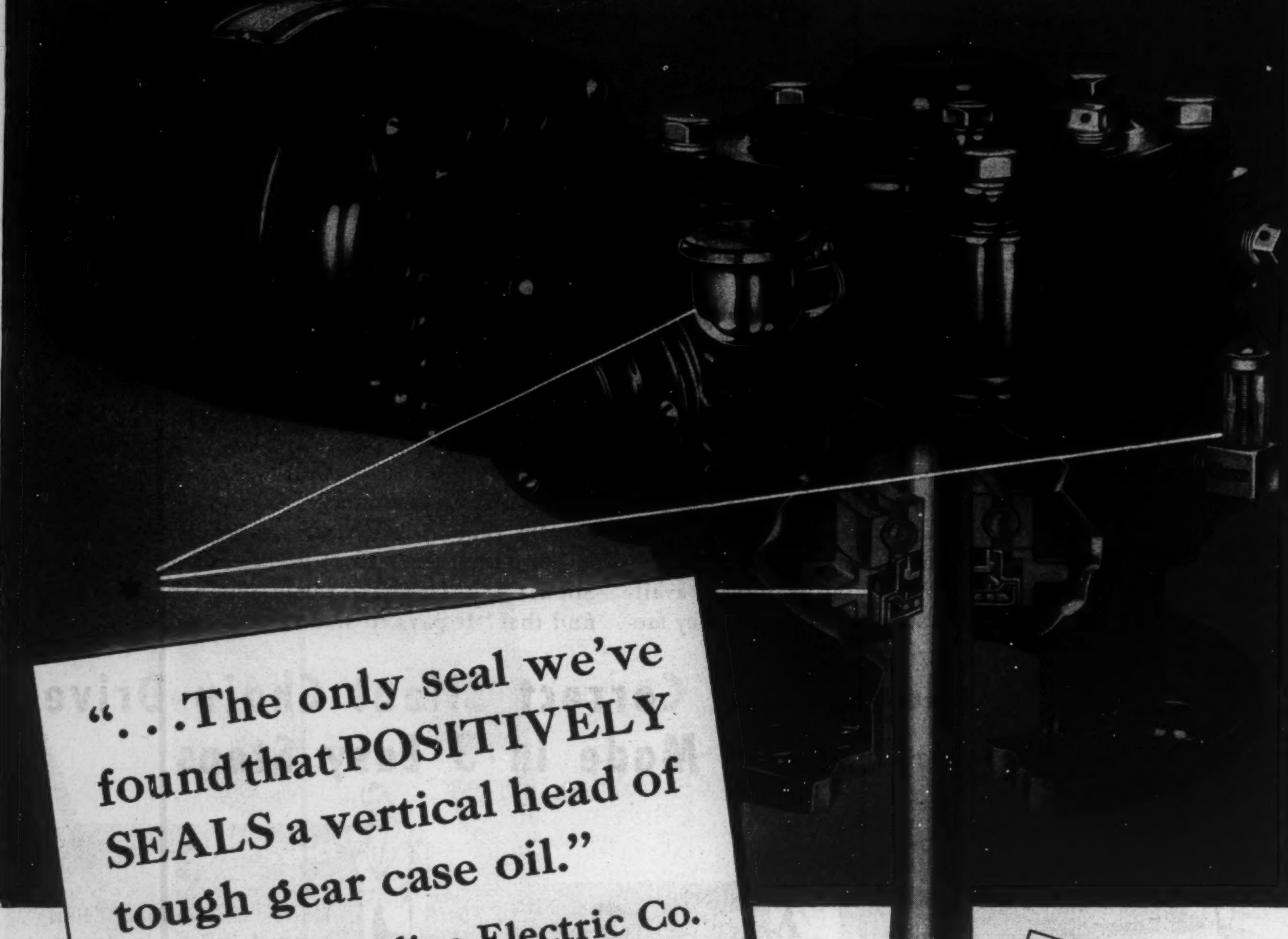
THE GITS *Unit* SEAL



"...The only seal we've found that POSITIVELY SEALS a vertical head of tough gear case oil."

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That's why Bodine Electric Company engineers chose the Gits Unit Seal for the Bodine "Group 4" worm gear reducer (shown here). Gits engineers then *applied* the Unit Seal without causing any redesign of the reducer.

Gits Seals can solve *your* shaft sealing problems, too—effectively and economically. Send us your shaft sealing problems on *any* type of equipment, for prompt recommendations (no obligation).

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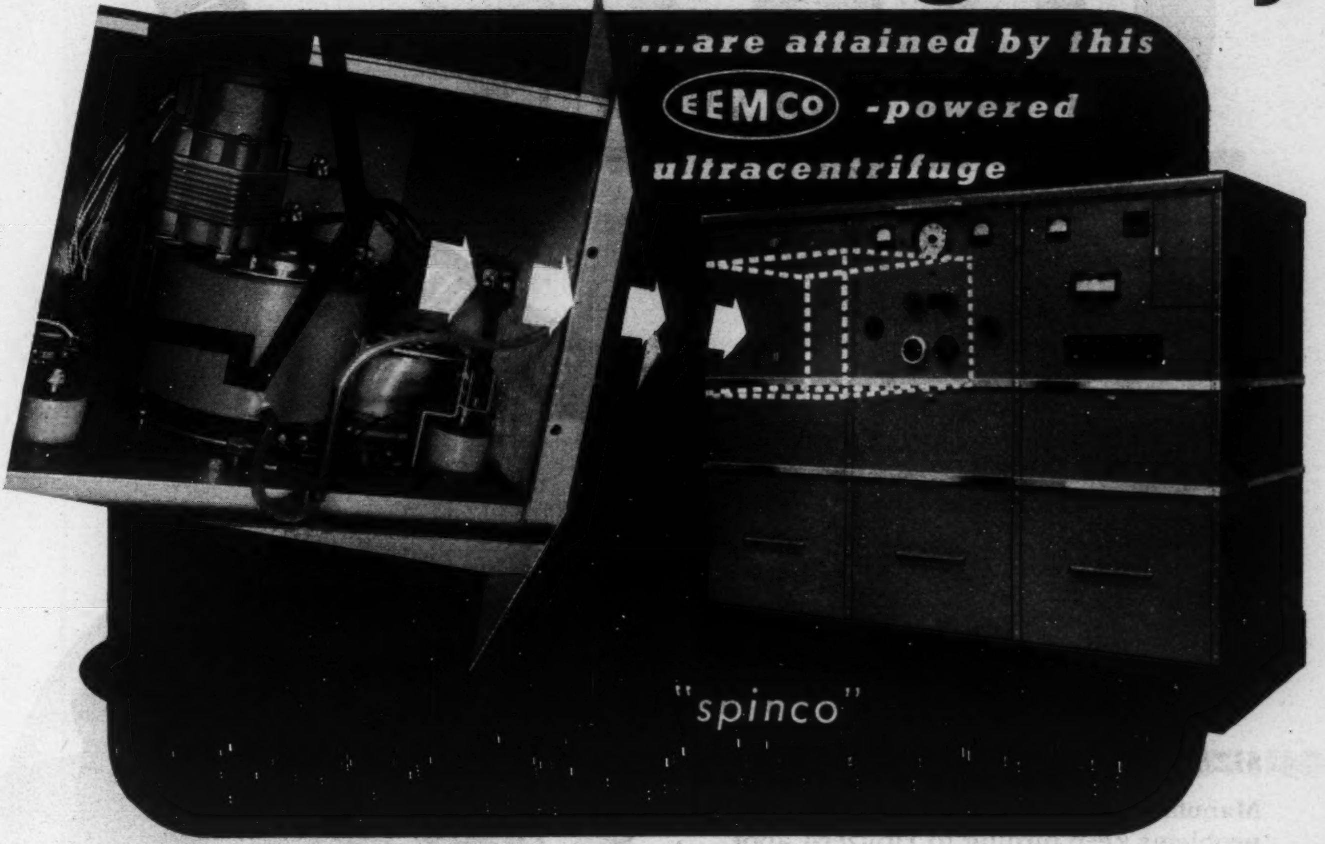
* Note the Gits "Style FG" Oil Gauge and the Gits "Style KV" Oil Cup. Gits oils it, seals it, gauges it!

Centrifugal forces over
250,000 times gravity



The terrific centrifugal forces, precision control, and utmost dependability required in operation of this fine laboratory device dictated special motor requirements. *EEMCO* engineers developed this special motor application to provide a powerful precision-speed-controlled electric drive capable of hundreds of hours of high speed operation without attention. The 1-1/2 hp motor operates on 110-volt current, AC or DC, at 12,000 rpm. It is both air and water cooled.

The manufacturers of the *"Spinco"* Ultracentrifuge, *Specialized Instruments Corporation,* Belmont, Calif., called on *EEMCO* for services typical of special motor development and manufacture performed by *EEMCO* for leading companies in diverse lines throughout the nation. *EEMCO* has solved the widely varying electric drive problems of manufacturers of ultrasonic sound generators, oil well recovery tools, power saws, radar equipment, submersible pumping units, aircraft, and dairy homogenizers.

EEMCO-designed motors and drive units have solved the very toughest problems of function, power, size, weight, shape, performance, installation and operation. Perhaps you need a completely special design...or we may be able to adapt a basic *EEMCO* design to meet your needs. Let *EEMCO* tackle *your* motor problem.

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SPECIAL MOTOR DESIGN
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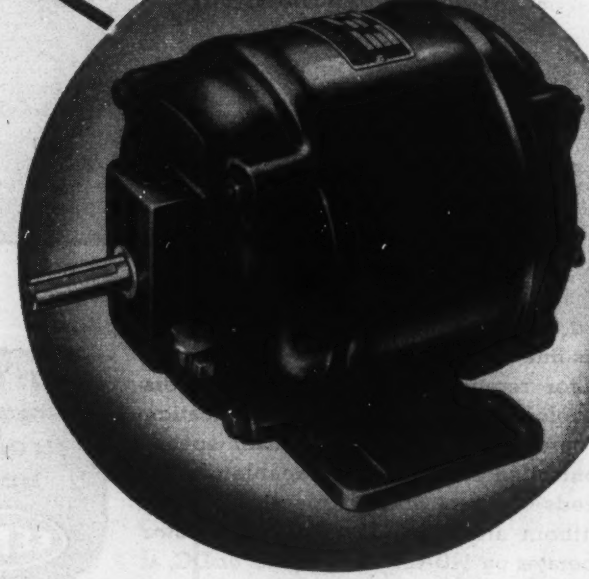
DEPENDABLE MOTORS FOR DEMANDING APPLICATIONS



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Manufacturers with motor application problems keep turning to Holtzer-Cabot —*and they get the answers!* Continuous duty motors . . . synchronous or induction, split phase or capacitor start . . . Holtzer-Cabot motors are available in a variety of types from the small instrument sizes up to heavy duty one horsepower units. Here are motors built for exacting requirements. In applications such as office and recording machinery, blower units, hoists, machine tools, fans, pumps and farm equipment, Holtzer-Cabot precision made motors have been proven in use by world famous manufacturers. Write or phone today for complete information.

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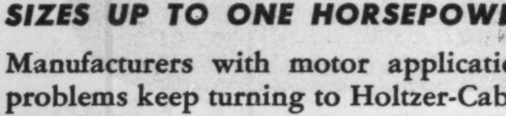

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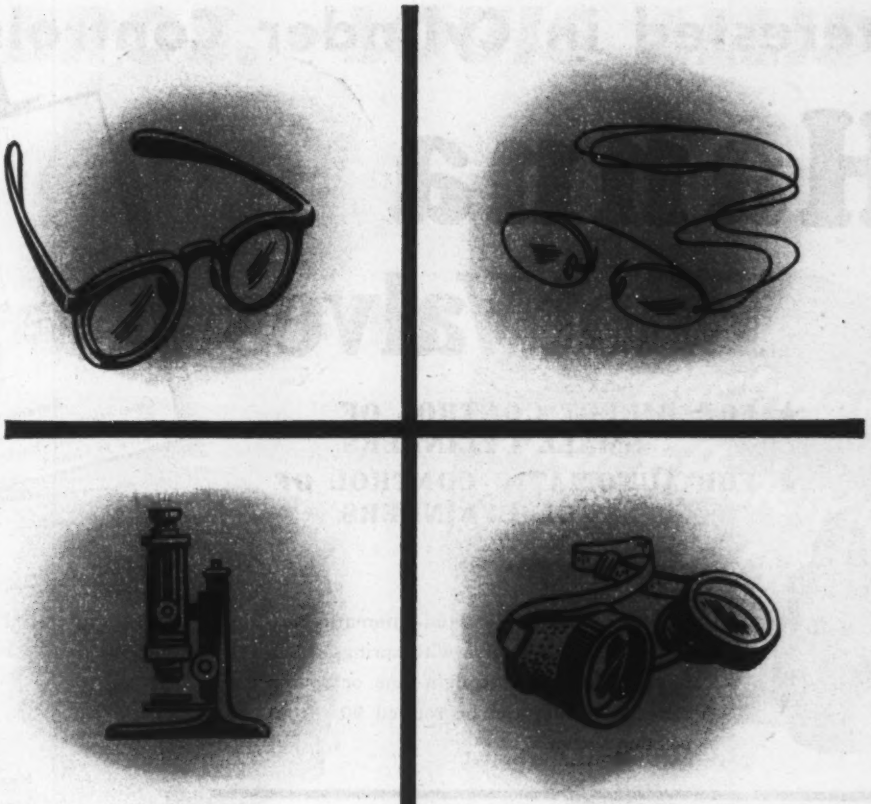

A TEAM OF EYES FOR BETTER STEEL CASTINGS

Knowing eyes, trained by long experience contribute to each step in the careful process of making Sivyer steel castings. The executive, the metallurgist, the foundryman, the grinder, even the salesman . . . all project and combine the resources of their individual skills and knowledge into a smoothly working team. Their goal . . . the production of the finest in high alloy castings.

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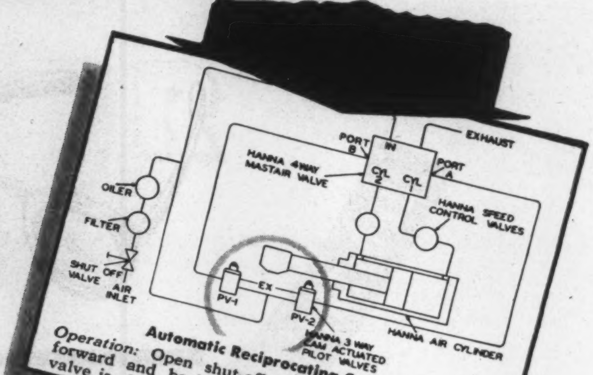
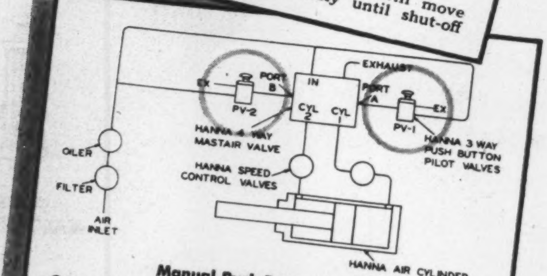

EXHAUST
PORT B
IN
PORT A
HANNA 4 WAY MASTAIR VALVE
CYL 2
CYL 1
OILER
FILTER
HANNA SPEED CONTROL VALVES
SHUT OFF VALVE
AIR INLET
PV-1
EX
PV-2
HANNA 3 WAY CAM ACTUATED PILOT VALVES
HANNA AIR CYLINDER

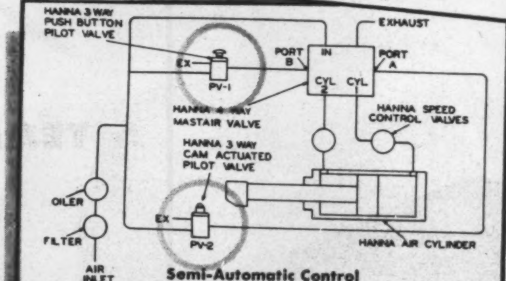
Automatic Reciprocating Control

Operation: Open shut-off valve. Piston will move forward and backward continuously until shut-off valve is closed.


EXHAUST
EX
PORT B
IN
PORT A
PV-2
CYL 2
CYL 1
PV-1
EX
HANNA 4 WAY MASTAIR VALVE
HANNA 3 WAY PUSH BUTTON PILOT VALVES
OILER
HANNA SPEED CONTROL VALVES
FILTER
AIR INLET
HANNA AIR CYLINDER

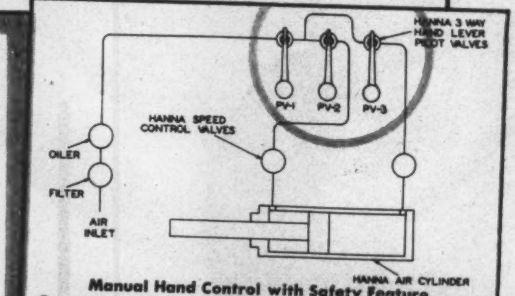
Manual Push Button Control

Operation: Press PV-1 and release. Piston will move to the right. Press PV-2 and release. Piston will move to the left.


HANNA 3 WAY PUSH BUTTON PILOT VALVE
EXHAUST
PORT B
IN
PORT A
EX
PV-1
CYL 2
CYL 1
HANNA 4 WAY MASTAIR VALVE
HANNA SPEED CONTROL VALVES
HANNA 3 WAY CAM ACTUATED PILOT VALVE
OILER
EX
FILTER
PV-2
HANNA AIR CYLINDER
AIR INLET

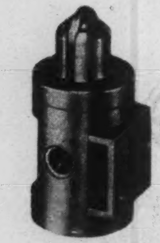
Semi-Automatic Control

Operation: Press PV-1 and release. Piston will move to the left, contact PV-2 and return.


HANNA 3 WAY HAND LEVER PILOT VALVES
PV-1
PV-2
PV-3
HANNA SPEED CONTROL VALVES
OILER
FILTER
AIR INLET
HANNA AIR CYLINDER

Manual Hand Control with Safety Feature

Operation: Press and hold down PV-1 and PV-2 and piston will move to the right. Press and hold down PV-1 and PV-3 and piston will move to the left. Purpose of PV-1 is to tie down both hands for safety.



CAM OPERATED

Ideal for automatic or semi-automatic control . . . A 3-way valve with spring-loaded roller actuated by straight line or rotary cam . . . Roller can be rotated 90° from position shown.

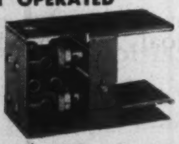
PUSH BUTTON OPERATED

Another compact 3-way Hanna Pilot Valve with push-button operation . . . excellent for control of panel operations—or where guards are used around valve to prevent accidental operation.

LEVER OPERATED

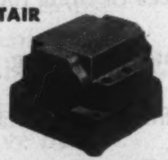
For manual control on fast, repeating and continuous operations . . . Efficiently used in circuits where safety is a factor . . . Lever can be rotated 90° . . . Cam, push-button and lever-operated valves all have optional brackets for side mounting.

FOOT OPERATED



Hanna 4-way Foot-operated Pilot Valves are available in single and double-pedal units for convenient, hand-free control of cylinders. The single-pedal valve is shown.

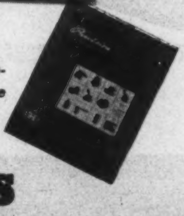
MASTAIR



Hanna 4-way Mastair Valve . . . A balanced spool type valve controlled by one 4-way or two 3-way pilot valves for automatic control of large cylinders.

Send for Catalog

New Hanna Valve Catalog No. 251 has illustrations, specifications and full details on the complete Hanna Valve line.



Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES . . . RIVETERS

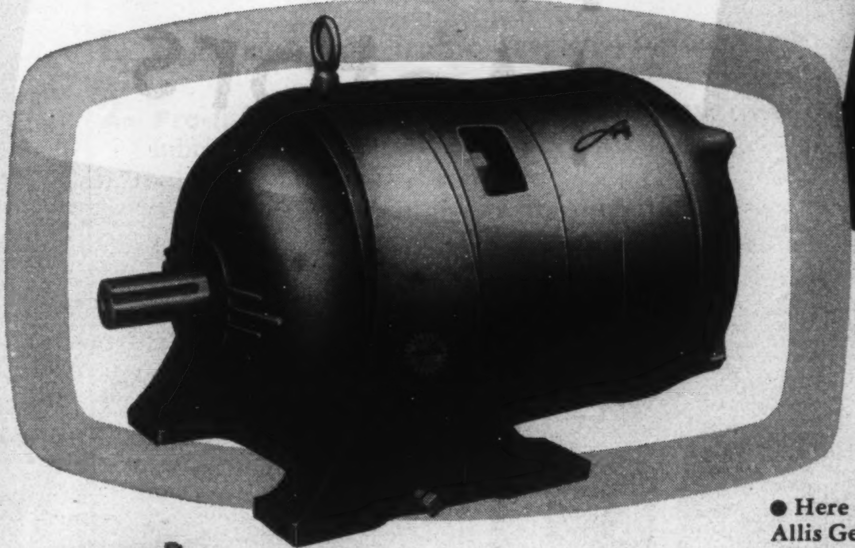
1765 Elston Avenue, Chicago 22, Illinois

FOOTE BROS.—LOUIS ALLIS

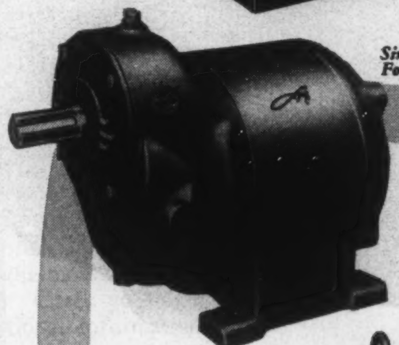
gearmotors

OFFER INDUSTRY

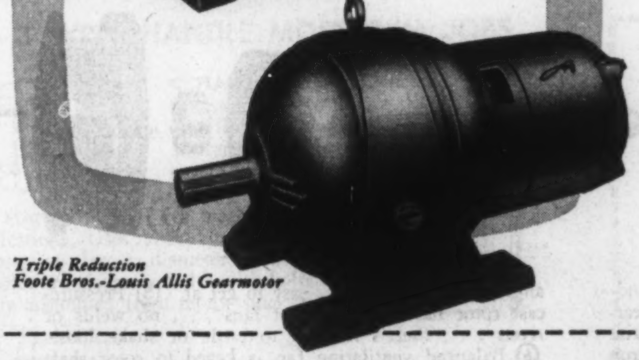
Compactness
High Efficiency
Long Life



Double Reduction
Foote Bros.-Louis Allis Gearmotor



Single Reduction
Foote Bros.-Louis Allis Gearmotor



Triple Reduction
Foote Bros.-Louis Allis Gearmotor

● Here is the new line of Foote Bros.-Louis Allis Gearmotors—modern in design, compact, efficient. Engineered to offer the maximum in performance—in year-in, year-out service—in minimum maintenance.

The units are powered by Louis Allis motors famous for quality for three generations.

A wide range of sizes and ratios is available in single, double and triple reductions in ratings of 1 h.p. through 75 h.p. with open drip-proof, enclosed, splashproof and explosion-proof motors.

These compact drives are engineered to occupy a minimum space, and the husky shafts and bearings permit large overhung load capacities.

Housings are sturdy castings—streamlined inside and out—and are designed for proper lubrication of gears and bearings.

Hardened helical gears are of highest quality. Extreme precision assures long, satisfactory service and quiet operation.

See your Foote Bros. representative or mail the coupon for information.

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. O, 4545 South Western Boulevard, Chicago 9, Illinois

Foote Bros. Gear and Machine Corporation
Dept. O, 4545 S. Western Blvd., Chicago 9, Illinois

Gentlemen:

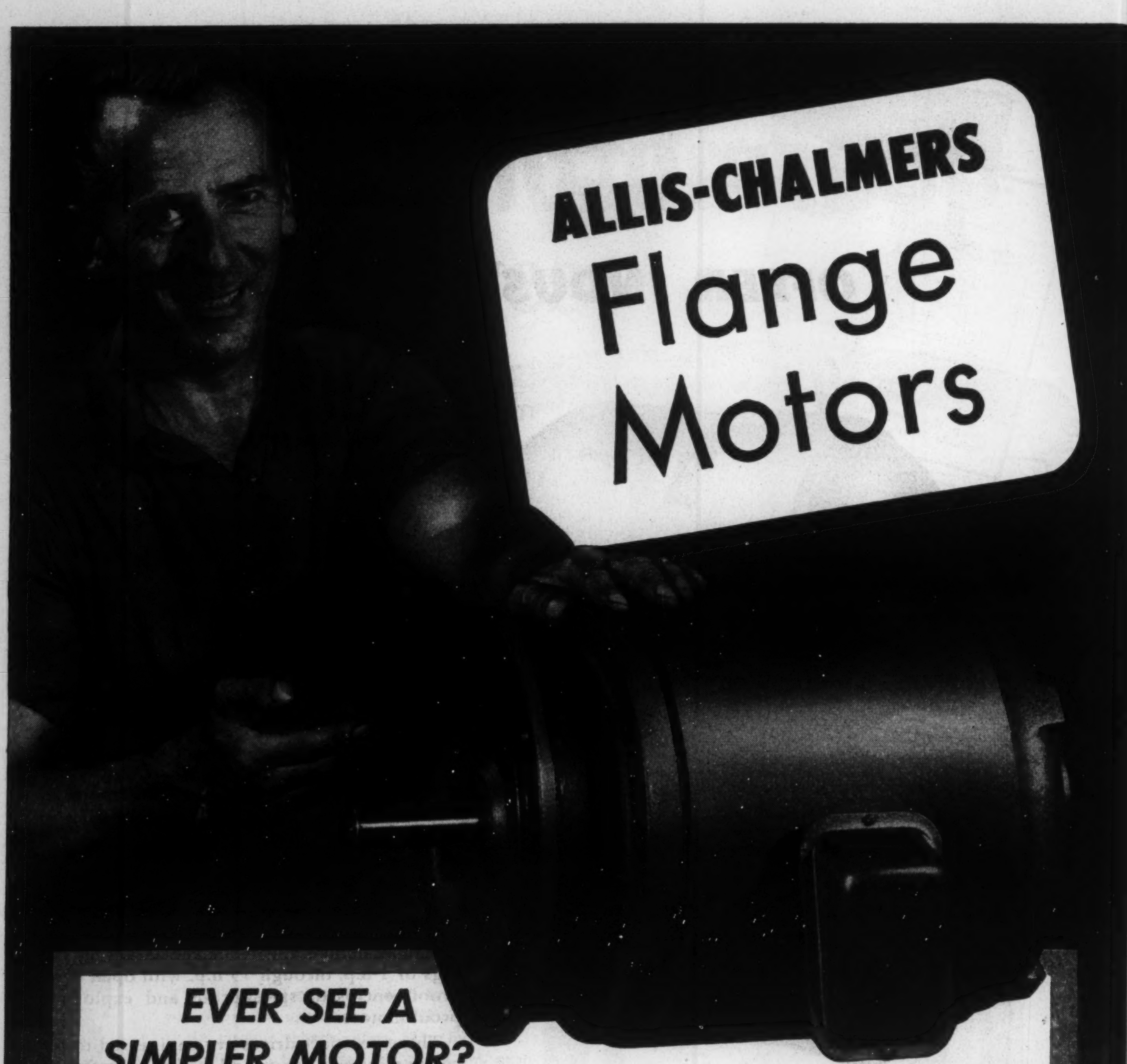
Please send me information on Foote Bros.-Louis Allis Gearmotors.

Name..

Company..

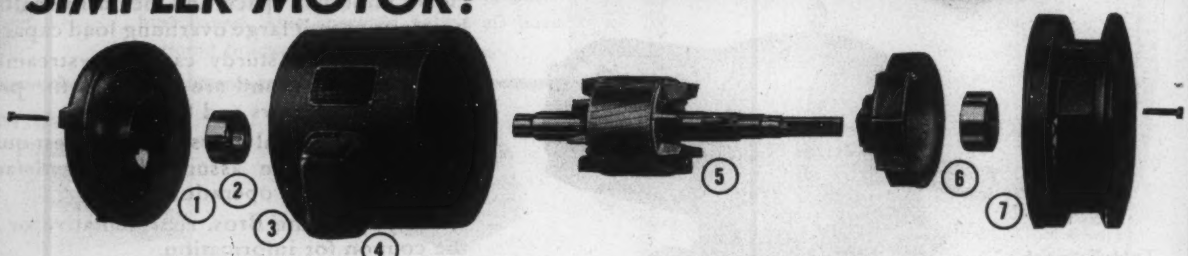
Address...

City...*State*.......................



ALLIS-CHALMERS Flange Motors

EVER SEE A SIMPLER MOTOR?



① Steel guard directs air stream toward stator windings for efficient cooling. ② Pre-lubricated ball bearings are simple press fit on motor shaft, they require no further lubrication for years. ③ Rigid, cast iron frame completely surrounds and protects stator core. ④ Diagonally-split conduit box is adjustable to any angle . . . is roomy . . . easy to get at. ⑤ Pressure-cast rotor has integrally cast fans . . . no welds or rivets . . . there's nothing to rattle or shake loose. ⑥ Balanced ventilating fan is keyed to rotor shaft . . . produces strong blast of cooling air. ⑦ Flange is counterbored for oil seal . . . has protecting mesh screens.

Sold — Applied — Serviced by Authorized Dealers, Certified Service Shops, and District Offices Throughout U. S.

ALLIS-

GIVE YOUR PRODUCT THIS 4-Point Motor Protection

1. **Rigid cast iron frame** completely surrounds all working parts . . . resists corrosion!

2. **Pre-lubricated bearings** eliminate bearing maintenance . . . require no further lubrication for years.

3. **Double-insulation** gives *extra* protection against heat, moisture, and corrosion.

4. **Pressure-cast rotor** has no rivets or welds . . . is indestructible in normal service.

Available in three flange types . . . sizes to 150 hp in open, enclosed and protected types, with electrical and mechanical modifications to suit specific requirements.

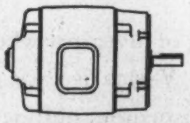
HERE'S A LINE OF FLANGE MOTORS you can design into your products and forget! Notice how *compact* these motors are . . . how *trim* in appearance. Further, their large, roomy conduit boxes and clearly marked connections make them *easy to install.*

Notice how the outer frame completely protects all working parts. This feature combined with pre-lubricated bearings and pressure cast rotors adds up to "all-around" protection against distortion, corrosion, friction and entrance of foreign matter. And bell housing is drip-proof, at no extra cost!

Best of all, these Allis-Chalmers motors are backed by a long-established record for building as tough and sturdy a line of motors as you can find anywhere on the motor market.

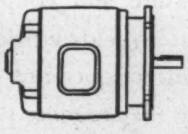
Check your needs in the coupon below for additional information.

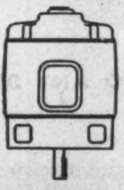
3 TYPES HANDLE MOST OEM JOBS



C FLANGE TYPE — Generally used for close coupling to pumps. Employs rabbet fit with mounting holes on smaller diameter than rabbet fit. Holes tapped for mounting bolts.

D FLANGE TYPE — For machine tool applications. Uses rabbet fit with mounting holes on larger diameter than rabbet. Holes are clearance holes with bolts usually assembled from motor side.



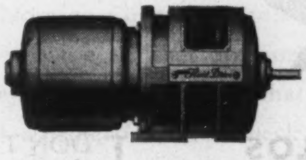


P BASE TYPE — Generally used for vertical applications. Employs rabbet fit with mounting holes on larger diameter than rabbet. Holes are clearance holes.

Texrope is an Allis-Chalmers trademark.

AMERICAN BLOWER GYROL FLUID DRIVES USE ALLIS-CHALMERS MOTORS

New Type TM Gyrol Fluid Drives offer benefits of low starting current, smooth acceleration and shock absorption in the 1 to 20 hp range.



These packaged power drives use Allis-Chalmers constant speed a-c flange motors to produce a smooth start. The motors come up to 85% of full speed before assuming load. Acceleration is gradual and there is a 50% saving in the amount of current consumed for starting. This unit makes overmotoring unnecessary and eliminates shocks to machinery. Overload protection is positive and can be adjusted by changing oil level in the unit. For additional information contact American Blower Corporation, Detroit 2, Michigan.

Check This Coupon

ALLIS-CHALMERS, 1001A SO. 70 ST.
MILWAUKEE, WIS.

Please send me:

- ☐ **Flange Motor Specification Sheet (51S7324).**
- ☐ **Handy Guide to Electric Motors (51B6052).**
- ☐ **General Purpose Motor Controls (14B7132).**
- ☐ **Equipment for Machine Tools (25B7110) (Contains information for OEM users on Motors, Texrope drives, Motor Controls, Coolant Pumps.**

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CHALMERS

"V-Belt Inventory?
... it's no problem
since we standardized
on VEELOS!"

4 REELS OF VEELOS *replace* 316 SIZES OF ENDLESS V-BELTS

Write for your VEELOS Data Book... it's free and it's full of engineering, measuring and installation information on Veelos. Everyone interested in power transmission should have a copy for ready reference.

MANHEIM MANUFACTURING & BELTING CO.
MANHEIM, PENNSYLVANIA

"I DON'T like to tie-up operating capital . . . who does? That's why, in our plant, we use Veelos on all v-belt drives. In the old days our stockroom was a dangling mess of endless v-belts. But no more. Now, on wall space only sixteen inches square, hang 4 reels of Veelos. Those 4 reels in O, A, B and C widths take care of *all* our v-belt needs. Simple story sure, but a sound, practical picture of saving money the Veelos way."

And there are other advantages beyond the saving of inventory when you standardize on Veelos, the adjustable v-belt. Veelos is easy to install—just measure and couple. You never dismantle outboard bearings to replace Veelos v-belts—that keeps machine downtime at rock bottom. Uniform operating tension, smooth, vibrationless power delivery and long life are more plus values from Veelos.

ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

VEELOS
THE LINK
V-BELT

Veelos is made in all standard sizes; fits all standard v-belt grooves. Packaged on reels in 100-foot lengths. Sales engineers in principal cities; over 350 distributors throughout the country. Veelos is known as VEELINK outside the United States.

An engineering answer to Engineers' search for...

BETTER PERFORMANCE

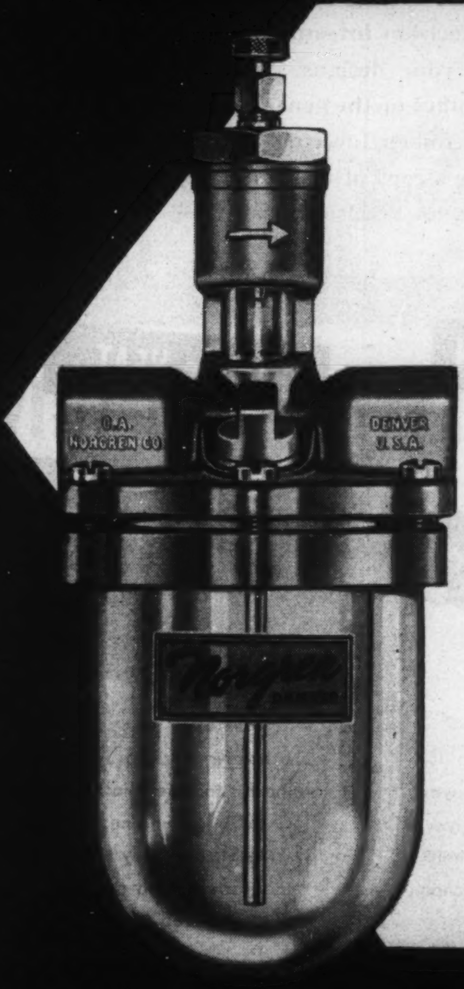
from the air-powered equipment they design!

● NORGREN AIRLINE LUBRICATORS are essential to the *continued peak performance* of every machine tool, hand tool, or other equipment operated wholly or in part by air. They are not a mere accessory—but should be an integral part of the air equipment you design.

Norgren Lubricators inject the *correct amount of oil* into the air that operates the tool or equipment. They create an *air-oil fog* that coats *every moving part* with a protective film. Check wear in use, stop corrosion when idle.

Fully automatic—lubricate only when the equipment operates—nothing to turn on or off. Visible oil feed. Needle valve adjustment for accurate flow requirements. Compact and attractive. Add an important sales point to your products.

Complete details . . . C. A. Norgren Co., 222 Santa Fe Drive, Denver 9, Colorado.



Proved by 20 years' service!

Norgren

Lubricators, Regulators, Filters, Valves, other Air Controls, Hose Assemblies

Super-Alloys in Intricate Shapes

with HAYNES *Precision Castings*

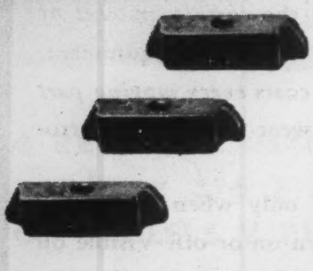
Trade-Mark

HAYNES precision investment castings are available in a range of alloys that are best suited to combat wear, heat, and chemical corrosion. These alloys—such as HAYNES STELLITE, HASTELLOY, MULTIMET, and various stainless steels—are often difficult and costly to machine, forge, or form into the desired shapes. They can, however, be precision investment-cast readily and economically.

If you're having trouble obtaining parts to meet severe operating conditions, investigate the precision investment-casting process. It enables you to specify intricate castings in large quantities—at reasonable prices. And parts are cast to such close dimensional tolerances that finishing operations are reduced to a minimum.

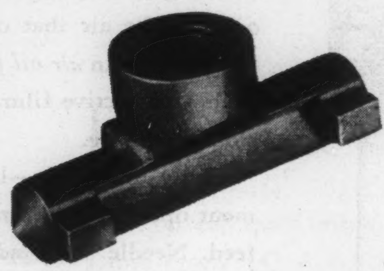
Our staff of engineers will help you decide where precision investment-cast parts can be used in your designs. Contact the nearest district office or the general office in Kokomo, Indiana, for engineering assistance. Ask also to receive a copy of the fully illustrated booklet, "HAYNES Precision Castings."

Resists WEAR



This part, which is used in a fuel control mechanism for gas turbine engines and operates without lubrication, is precision investment-cast of HAYNES STELLITE 98M2 alloy to resist the severe abrasion encountered in operation.

Resists CORROSION



Type 316 stainless steel was selected for this float rod driver, used in a control instrument, because it must withstand the action of corrosive solutions.

Resists HEAT

The hollow nozzle diaphragm partition for the General Electric J-47 (TG-190) jet engine is made of HAYNES STELLITE alloy No. 21. It must remain strong and corrosion-resistant at elevated temperatures.

HAYNES

TRADE-MARK

alloys

Haynes Stellite Company

Unit of Union Carbide and Carbon Corporation

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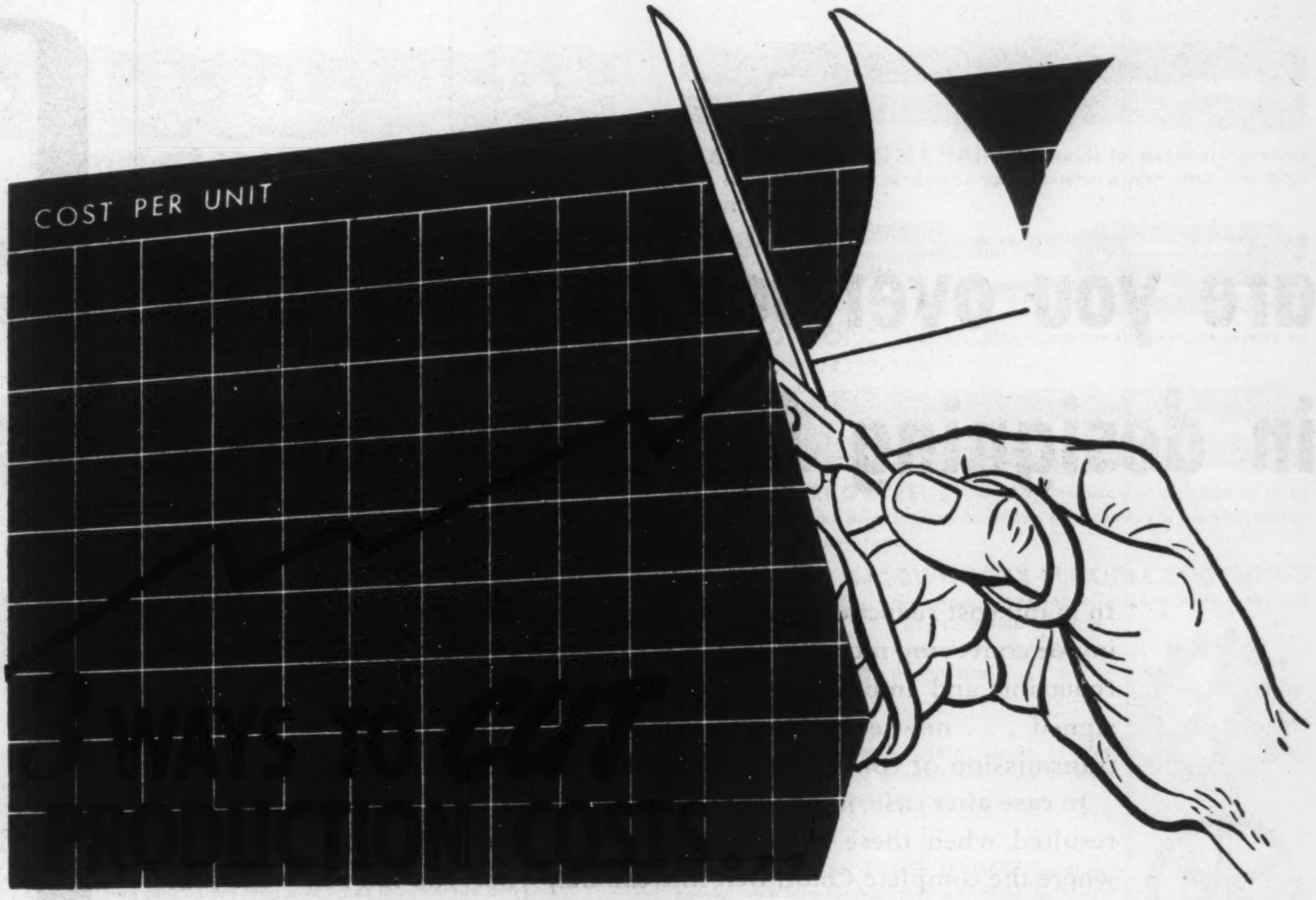
Chicago—Cleveland—Detroit—Houston

Los Angeles—New York—San Francisco—Tulsa

The trade-marks "Haynes," "Haynes Stellite," "Hastelloy," and "Multimet" distinguish products of Haynes Stellite Company.



WITH PERMITE ALUMINUM CASTINGS

A change from heavy metal to lightweight Permite Aluminum Castings can bring you these definite cost cutting savings:

1. Save on Cost of Handling

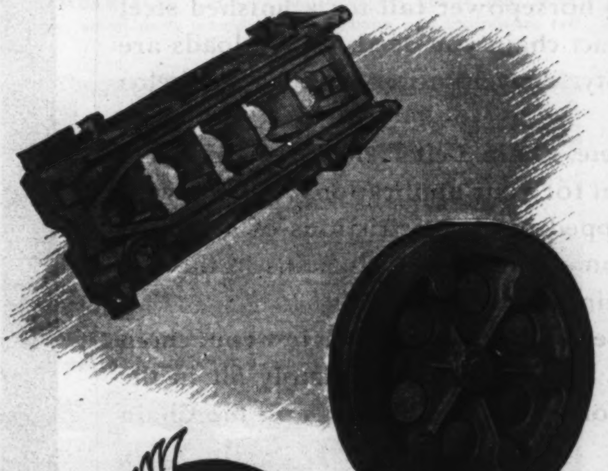
Permite Aluminum Castings are approximately 60% lighter than cast iron and 65% lighter than steel, brass and bronze. They're lighter to handle, lighter to assemble, lighter to ship as a finished product. So you cut handling costs all along the line!

2. Save on Cost of Finishing

The consistent uniformity of Permite Aluminum Castings within close tolerances makes only a minimum of machining necessary. Higher machine speeds and deeper cuts are practical with Permite Aluminum Castings, with only slight changes in tool contours. Time spent per unit in shaper, drill press or milling machine is appreciably less! And aluminum stays bright without painting or expensive plated coatings.

3. Longer Service, Fewer Replacements Mean Long-Range Savings

High tensile strength; resistance to corrosion; rapid heat transfer; and special to-fit-the-job designing by Permite engineers enable Permite Castings to give longer, better service! You save three ways with Permite and get better appearance, a better product.



Why not write us about your castings requirements and get our recommendations and quotations?

PERMITE

ALUMINUM INDUSTRIES, INC.
CINCINNATI 25, OHIO

ALUMINUM PERMANENT MOLD, SAND and DIE CASTINGS . . . HARDENED, GROUND and FORGED STEEL PARTS

are you overlooking these bets in designing for lower costs?

In many cost reduction programs, too often the power transmission, timing or conveying method is taken for granted . . . the possibilities for cost reduction and improved performance overlooked. Equipment is redesigned . . . new equipment developed but with the same basic power transmission or conveying medium that has served for years.

In case after case, important savings in cost . . . increased efficiency have resulted when these basic functions have been redesigned. And that's where the complete Chain Belt line can help you. You can select the exact chain that best fits the operating conditions or horsepower and speed requirements.

Where operating conditions call for a cast chain, you'll find the exact type and size needed. If speeds and horsepower call for a finished steel roller chain, again you'll find the exact chain you need. Where loads are extra heavy or operation is in dusty, dirty locations, a steel Chabelco chain may be the answer.

Because their chain line is complete, Chain Belt Field Sales Engineers can recommend the chain that is right for your applications . . . for lowest overall cost. They are not handicapped by the restrictions of a limited line . . . can, without prejudice, recommend cast or steel chains in the size and type that are best for your machines.

Your Chain Belt Field Sales Engineer will be happy to review your chain selection and application problems. Or, if you prefer, simply fill in the coupon at the right for descriptive bulletins on the Chain Belt Company line.

CHAIN BELT
REX
COMPANY

CHAIN BELT COMPANY

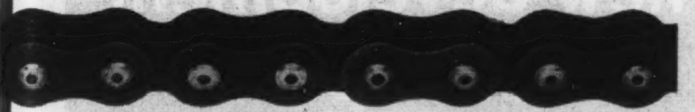
REX CHAIN & TRANSMISSION DIVISION
Milwaukee 4, Wisconsin

BALDWIN-DUCKWORTH DIVISION
Springfield 2, Massachusetts

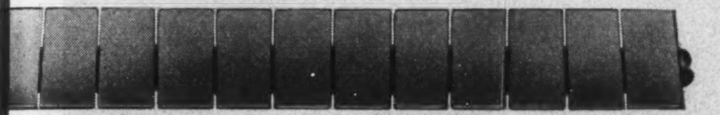
BALDWIN-REX ROLLER CHAIN available in a complete range from ¼-inch to 2½-inch pitch for high speed power transmission and timing.

BALDWIN-REX DOUBLE PITCH ROLLER CHAIN for economical power transmission and conveying under slow speeds.

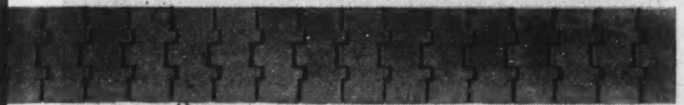
BALDWIN-REX "BA" ROLLER CHAIN, a new development in the larger pitch riveted chains with a single pin connector that makes assembly and disassembly easy.



BALDWIN-REX LEAF (Cable) CHAIN, an economical chain for lifting or pulling service particularly on hydraulic mechanism.



BALDWIN-REX PLATE TOP CHAIN for conveying bottles or jars where centers are long and loads moderate to heavy.



REX TABLE TOP CHAIN for conveying bottles, jars, cans, packages, small parts where smooth transfer and cleanliness are required.

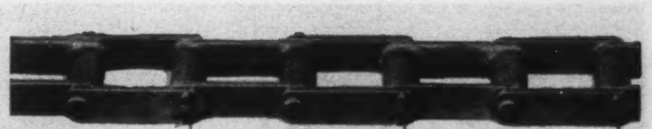
REX DETACHABLE CHAIN, available in both pressed steel (shown) and cast types for light drives and conveyor service.

REX PINTLE CHAIN, a drive and conveyor chain used where long life due to greater bearing area is needed.

REX H-TYPE CHAIN for use extensively for drive and transfer service where the wide wearing shoes add life in sliding applications.

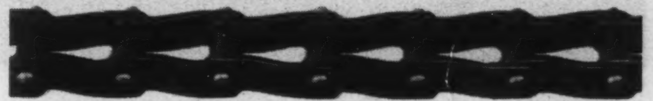
These chains are representative of the complete Chain Belt Line. There are many other sizes and types as well as a complete range of chain attachments for every type of conveyor service.

BALDWIN·REX

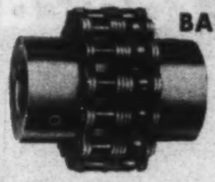


REX COMBINATION CHAINS, suitable for general elevating and conveyor work at slower speeds where low cost and high strength are needed.

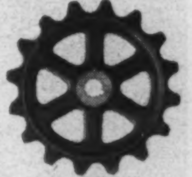
REX DROP FORGED CHAINS, used for trolley conveyors or floor-type sliding conveyors.



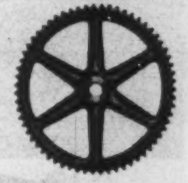
REX CHABELCO STEEL CHAINS, available in a range of sizes from 1¼-inch to 36-inch pitch for drive and conveyor service under moderate to heavy loads.



BALDWIN-REX FLEXIBLE COUPLINGS are shock absorbing, eliminate back-lash, are easy to install. Made in 5 styles for every coupling service.



REX CAST TOOTH SPROCKETS, made of close grained gray iron. For greatest resistance to wear, available in Rex Temperim.



BALDWIN-REX CUT TOOTH SPROCKETS, cut with special tooth form for maximum efficiency, quiet operation and long life.

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CHAIN BELT COMPANY
1643 W. Bruce Street, Milwaukee 4, Wis.

Gentlemen:

I am particularly interested in..

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☐ Please send me descriptive bulletins.

☐ I would like to have a Rex Field Sales Engineer call on me regarding my chain application problems.

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Company.. *Department*..........................

Address...

City.. *State*................................

K+E

partners

for 82 years K&E equipment and materials have been

a radical new development
in woven tapes
9
45
1
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2
3

PHOENIX WYTEFACE Non-metallic Woven Tapes.

Trade Mark

U. S. Pat. 2,321,920

OVER 3 TIMES LONGER WEAR. An enormous stride. A radical development. The new *non-metallic* PHOENIX WYTEFACE, as one highway engineer puts it, *"has at least three times the life of ordinary metallic tapes"*. Drastic field tests—in extremes of climate, in water and mud, over stones and rocks, under truck wheels, through brush and barbed wire—have established that fact.

Here is the reason. PHOENIX WYTEFACE is a weave of amazingly strong synthetic yarns—a scientific wartime development—completely covered and protected by a special tough plastic coating that is not affected by water, is not brittle and will not flake.

MORE ACCURATE. PHOENIX WYTEFACE will stand up to repeated soaking and drying and still maintain a dimensional stability substantially higher than that of ordinary so-called "metallic" tapes.

HIGHER DIELECTRIC CONSTANT. PHOENIX WYTEFACE Woven Tapes are entirely non-metallic—a feature that is important to Power and Utility Companies and to anyone working near high tension circuits.

EASY TO READ AND CLEAN. The clear black and red markings on the white background are easy to read. The surface is easily wiped clean.

Ask your K&E Distributor or any K&E Branch to show you the new PHOENIX WYTEFACE non-metallic Woven Tape, or write on your letterhead for a sample length to Keuffel & Esser Co., Hoboken, N. J.

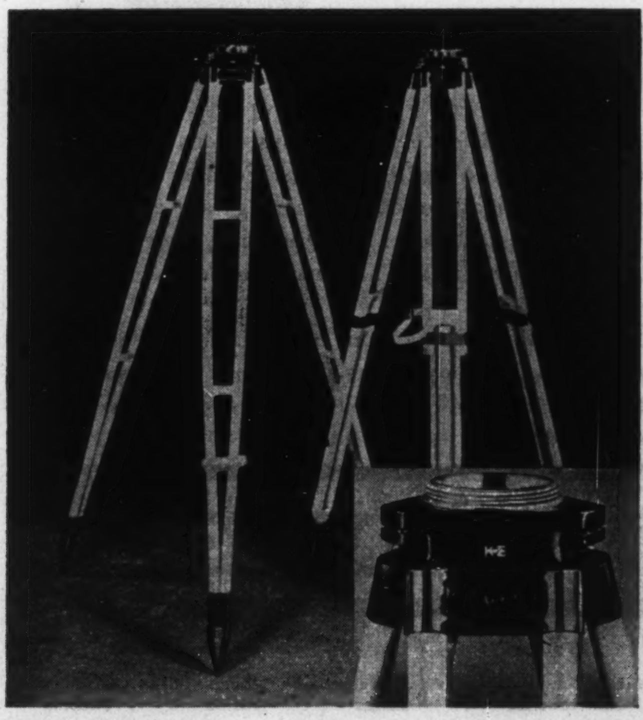
in creating . . .

partners of the draftsman, the engineer and the scientist in shaping the modern world

NEW K&E WIDE FRAMED TRIPODS GIVE MAXIMUM STABILITY

The wide framed leg construction of these new K&E tripods and the wide, all-metal hinges joining the legs and head result in great torsional stability. This makes the instrument much steadier—less vibration—in windy weather. Legs are straight grained maple. They are easy to plant firmly, because of their long steel "Stoodite" tipped shoes and large spurs—the kind a man can get his foot on, even with boots or galoshes. The head fits all instruments with the standard 3½ inch by 8 threads. K&E Wide Framed Tripods are made in stiff leg and extension styles.

Ask your K&E Dealer or Branch to show you these tripods, or write to Keuffel & Esser Co., Hoboken, N. J.



ALBANENE* TRACING PAPER WILL NOT DETERIORATE WITH TIME

ALBANENE Tracing Paper is made from a 100% pure rag base. Its fine printing transparency is due, not to oils that leak and "bleed," but to a synthetic transparentizer that K&E developed specially for this purpose. Prints made today from drawings made on ALBANENE years ago, prove conclusively that ALBANENE does not turn brittle nor lose its transparency with time.

Ask your K&E Distributor or any K&E Branch for a sample or write to Keuffel & Esser Co., Hoboken, N. J.

*Trade Mark ®

K+E

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The
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Solution
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Small
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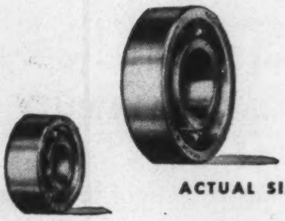

NORMA-HOFFMANN Small BEARINGS . . .

Wherever your designs call for *small* bearings, that's the time to *specify* and *use* Norma-Hoffmann Small Bearings. For like all Norma-Hoffmann bearings, these small precision bearings are engineered to give efficient, trouble-free service for years on end. They are extra quiet in operation . . . require little if any maintenance . . . improve the performance of the product.

Write for catalog describing these *small* bearings as well as other Norma-Hoffmann Bearings. They are available in a wide range of types and sizes from 1/8″ to 22½″ bore . . . a type and size to meet every speed, load and duty.

NORMA-HOFFMANN
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BALL · ROLLER · THRUST

NORMA-HOFFMANN BEARINGS CORPORATION
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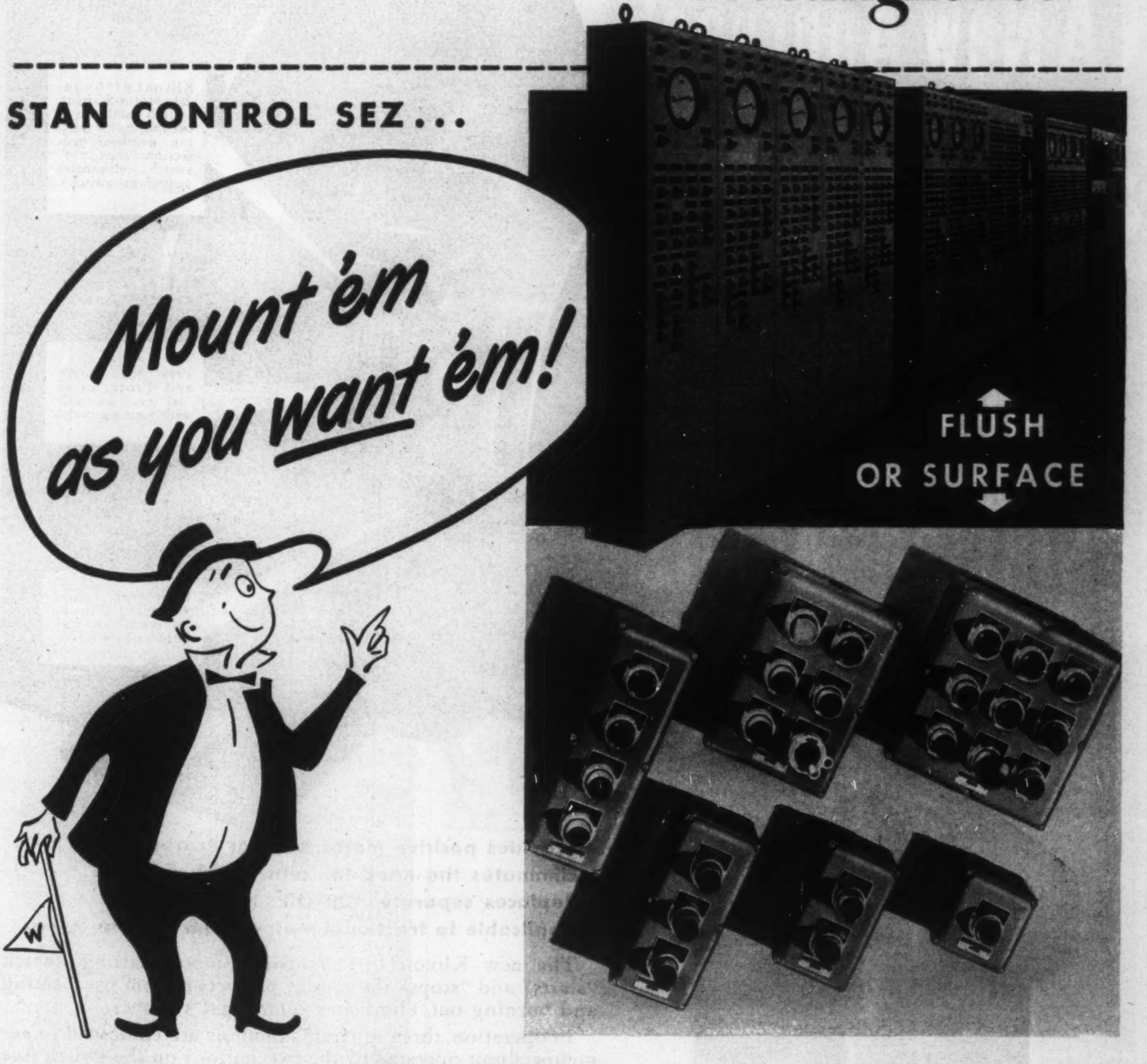
YOU CAN BE **SURE**.. IF IT'S

Westinghouse

STAN CONTROL SEZ...


Mount 'em as you want 'em!
FLUSH
OR SURFACE
W

Westinghouse Oil-Tite Control Stations and Units improve control operations on all types of pilot-control circuits and controllers. Their unit flexibility makes possible attractive installations to suit particular needs.

For surface mounting, they are available in handsome, die-cast Bonderized enclosures. The sleek design and smooth, baked enamel finish harmonize with modern industrial design. Contact blocks may be mounted in the base, eliminating flexible leads from box to cover. Nine operator assemblies and six enclosures provide circuit combinations for any requirement.

When it is desired to mount units in machine cavities, or in banks in large control stations, the contact blocks may be mounted in the conventional manner. For flush mounting in machine cavities, the controls can be purchased with covers only, which become convenient and attractive flush plates.

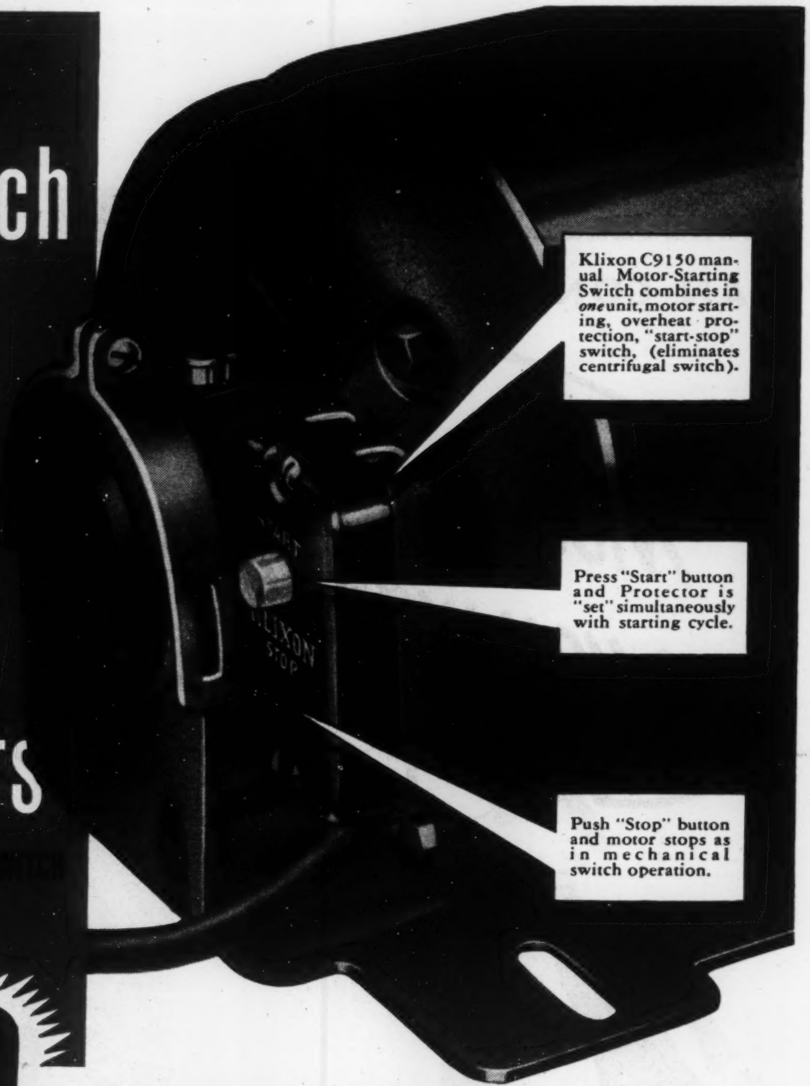
Get complete information from your nearby Westinghouse office. Ask for bulletin DB-15-022. Or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-30010

Oil-Tite

WESTINGHOUSE

A New Approach to Overheat Protection of Manually Started Motors

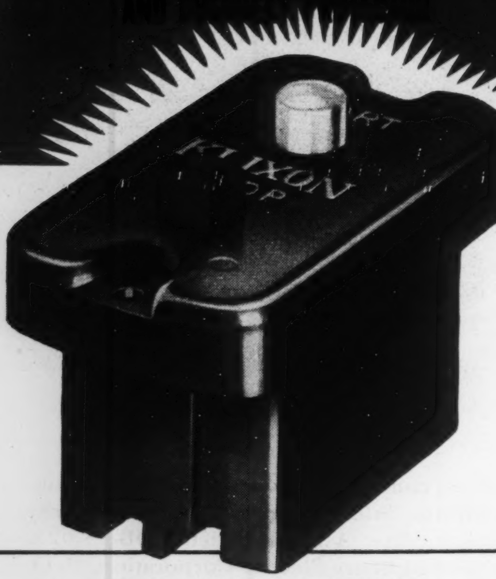
KLIXON C9150 MANUAL MOTOR-STARTING SWITCH AND OVERHEAT PROTECTOR



Klixon C9150 manual Motor-Starting Switch combines in *one* unit, motor starting, overheat protection, "start-stop" switch, (eliminates centrifugal switch).

Press "Start" button and Protector is "set" simultaneously with starting cycle.

Push "Stop" button and motor stops as in mechanical switch operation.



- **Provides positive Motor Burnout Protection.**
- **Eliminates the need for centrifugal switches.**
- **Replaces separate "On-Off" line switches.**
- **Applicable to fractional motors from 1/12 to ½ hp.**

The new Klixon C9150 manual motor-starting switch "starts" and "stops" the motor, protects it from overheating and burning out, eliminates centrifugal switches.

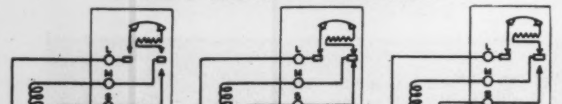
In operation, three separate functions are combined in *one* compact unit operated by the two buttons on the switch (see schematic wiring drawings at left).

The Spencer thermal Disc provides positive overheat protection... prevents the motor from burning out under dangerous overloads or stalled rotor conditions. When the overload is cleared or motor cools to safe operating temperature, the motor is started by pushing the "start" button which resets the protector simultaneously with the starting cycle.

Investigate the new Klixon C9150 manual motor-starting switch. It has a wide range of applications such as, washing machines, bench grinders, . . . many types of appliances and equipment using manually started fractional hp. motors from 1/12 to ½ hp.

Because of detailed data required for rating determination this switch is applicable only by motor manufacturers or appliance manufacturers.

HERE'S HOW IT OPERATES



Schematic wiring diagram shows switch in "off" position. The switch incorporates two sets of normally open contacts and a Klixon Manual reset Protector.

Pushing "start" button closes contacts energizing both main and phase windings ... latches button in running position ... sets protector.

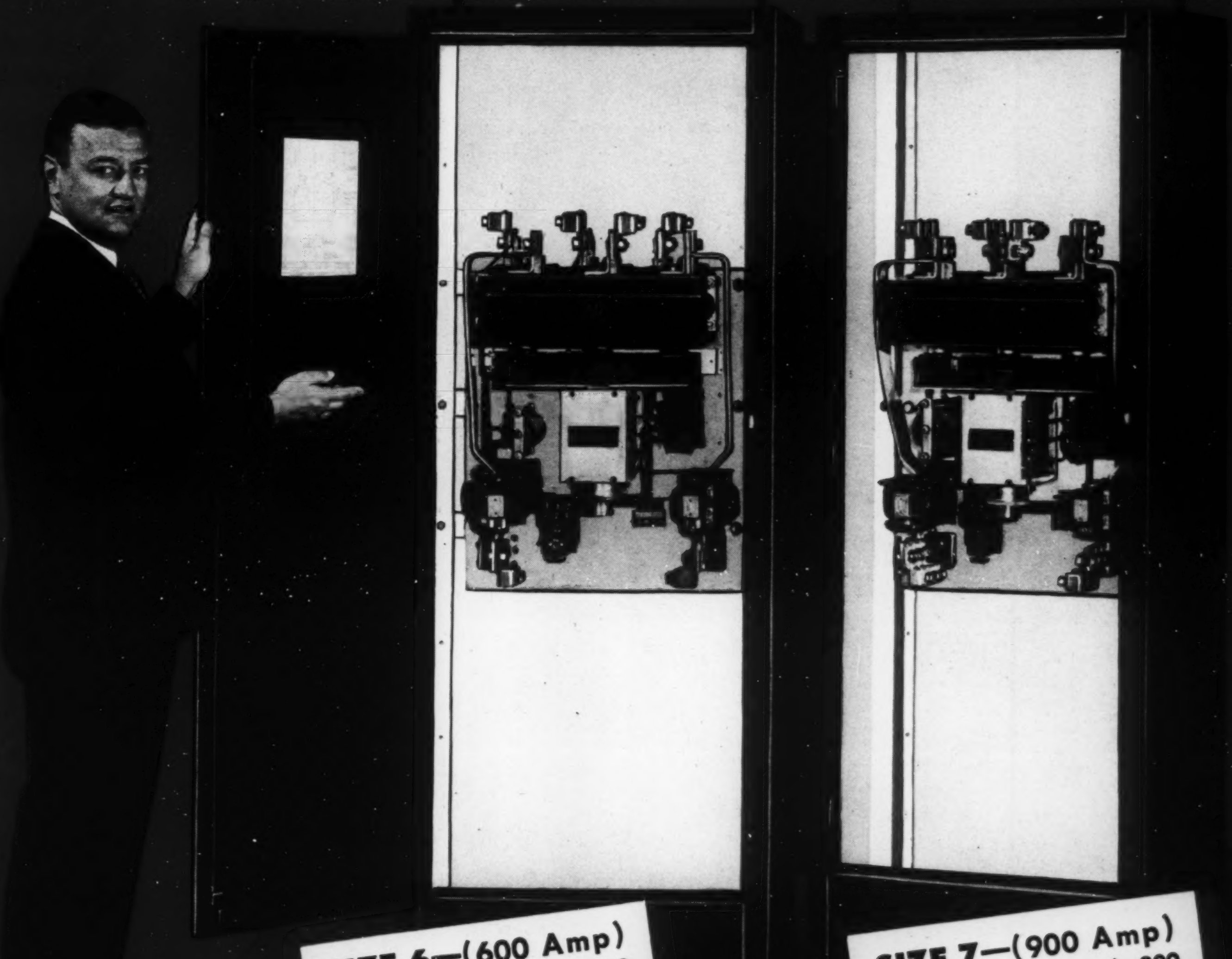
The "start" button is then released opening phase winding contacts but main winding contacts remain closed and the motor runs.

KLIXON

SPENCER THERMOSTAT *Division of Metals & Controls Corp.*
2521 FOREST STREET, ATTLEBORO, MASSACHUSETTS

Announcing...

The NEW Size 6 and Size 7 SOLENOID Starters



SIZE 6—(600 Amp)
Max Rating (3 phase): 200 Hp, 220 volts; 400 Hp, 440-550 volts.

SIZE 7—(900 Amp)
Max Rating (3 phase): 300 Hp, 220 volts; 600 Hp, 440-550 volts.

A-B Quality

ALLEN-BRADLEY

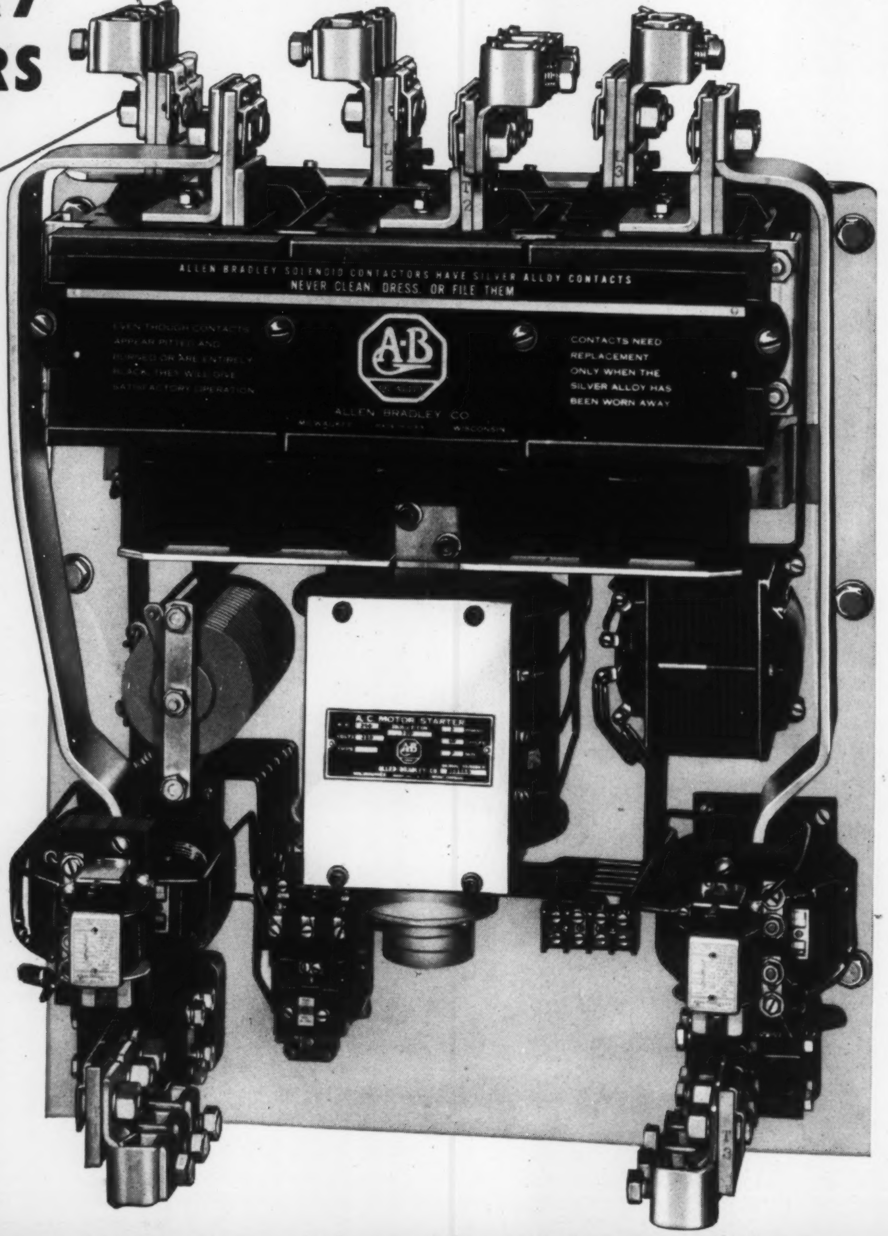
SOLENOID MOTOR CONTROL

SEE OTHER SIDE

Now- All the Advantages of SOLENOID design

in the NEW SIZES 6 & 7 STARTERS

In years of service, under all operating conditions, the Allen-Bradley solenoid construction has proved its superiority beyond all question of doubt. Now Allen-Bradley has developed Sizes 6 and 7 solenoid starters . . . with all the features that have proved so successful in smaller Allen-Bradley starters. Check its many features.


ALLEN BRADLEY SOLENOID CONTACTORS HAVE SILVER ALLOY CONTACTS
NEVER CLEAN, DRESS, OR FILE THEM
EVEN THOUGH CONTACTS APPEAR PITTED AND ROUGHED OR ARE ENTIRELY BLACK, THEY WILL GIVE SATISFACTORY OPERATION
A-B
ALLEN BRADLEY CO.
CONTACTS NEED REPLACEMENT ONLY WHEN THE SILVER ALLOY HAS BEEN WORN AWAY
A.C. MOTOR STARTER

SILVER ALLOY CONTACTS

The double break, silver alloy contacts never require cleaning or filing—a distinct advantage over conventional copper-to-copper contacts.

SIMPLE, RUGGED CONSTRUCTION

These starters have no pins, pivots, hinges, or complicated mechanisms to cause trouble. The solenoid switch mechanism has only one moving part.

SMALLER SIZE

The open type Size 6 starter is less than ¼ as large as conventional starters, and the enclosed unit takes only 58% of the floor space. Size 7 is even smaller, compared with other starters.

STEEL PANEL MOUNTING

The switch is mounted on a metal base plate instead of a slate panel, and is self insulated. It can be quickly and easily mounted to metal surfaces without additional insulation.

FRONT-OF-PANEL WIRING

All terminals and wiring are readily accessible from the front. There is no back panel wiring.

AVAILABLE IN MANY FORMS

Size 6 and Size 7 solenoid switches can be furnished in 2 pole or 3 pole contactors, across the line starters, reversing switches, reduced voltage starters, and many other combinations where clapper type switches were previously used.

Write for Information

Allen-Bradley Co., 1316 S. Second St.
Milwaukee 4, Wis.

A-B
Quality

ALLEN-BRADLEY

SOLENOID MOTOR CONTROL

QUALITY

K-68

the sheet packing that overcomes problems due to "oil swell"

The swelling that takes place when gaskets are in contact with hot oil or gasoline often causes troublesome or dangerous leaks. K-68 sheet packing was specially designed by R/M packing engineers to overcome this problem in aircraft engines. It meets specification AMS-3232 in all its difficult requirements.

To insure a tight seal between hot metal parts, gaskets that will not be seriously affected by gasolines, naphthas, diesel fuels, and hot oil products, specify K-68.

K-68 is made of selected asbestos fibres, bonded with Neoprene only, under great pressure. It is available in thicknesses from 1/64″ to 1/8″ and in widths up to 60″. For data on K-68 or for the latest R/M packing catalog, send the coupon below.

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PACKING DIVISION, MANHEIM, PA.

FACTORIES:
Bridgeport, Conn.; Manheim, Pa.;
No. Charleston, S.C.; Passaic, N.J.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Asbestos Textiles Mechanical Rubber Products • Abrasive and Diamond Wheels • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Rubber Covered Equipment Powdered Metal Products • Bowling Balls

RM

MD12

Raybestos-Manhattan, Inc.
Packing Division, Manheim, Pa.

Gentlemen: ☐ Please send me a free copy of the R/M Packing Catalog.
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Apparatus Dept., Sect. B 720-8,
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CUT ALONG DOTTED LINE

send for these Free Bulletins

for your heating jobs

HEATING LIQUIDS "Built-in" electric heat makes your product a better product because it *puts the heat right where it is wanted!* "Immersion heating" with G-E Calrod* heaters places heat source into the material to be heated . . . for maximum heat transfer with minimum heat losses.

HEATING PIPELINES G-E heating cable and Calrod tubular heaters keep viscous liquids free-flowing and protect pipelines and valves in cold weather . . . a wealth of "how to" information on installation, application and power requirement calculation.

HEATING PROCESS AIR How and where to apply G-E strip, Calrod tubular and fin Calrod heaters for drying, baking, warming, curing and a wide range of industrial processes and equipments.

HEATING SURFACES Whether it's an eighth-inch soldering iron tip or 100 square-feet of platen surface, this bulletin tells you how to calculate your heating requirements . . . which G-E Calrod heater to use and where and how to install it.

MELTING SOFT METALS Here's how you can achieve fast melting and fully automatic temperature control of babbitt, solder, lead, tin, and type metals—with reduced operation costs, less maintenance, and cooler working conditions.

ELECTRIC HEATERS AND HEATING DEVICES New revised catalog lists a wide variety of heaters and devices to meet almost any conceivable heating requirement.

HEAT
WHERE YOU WANT IT

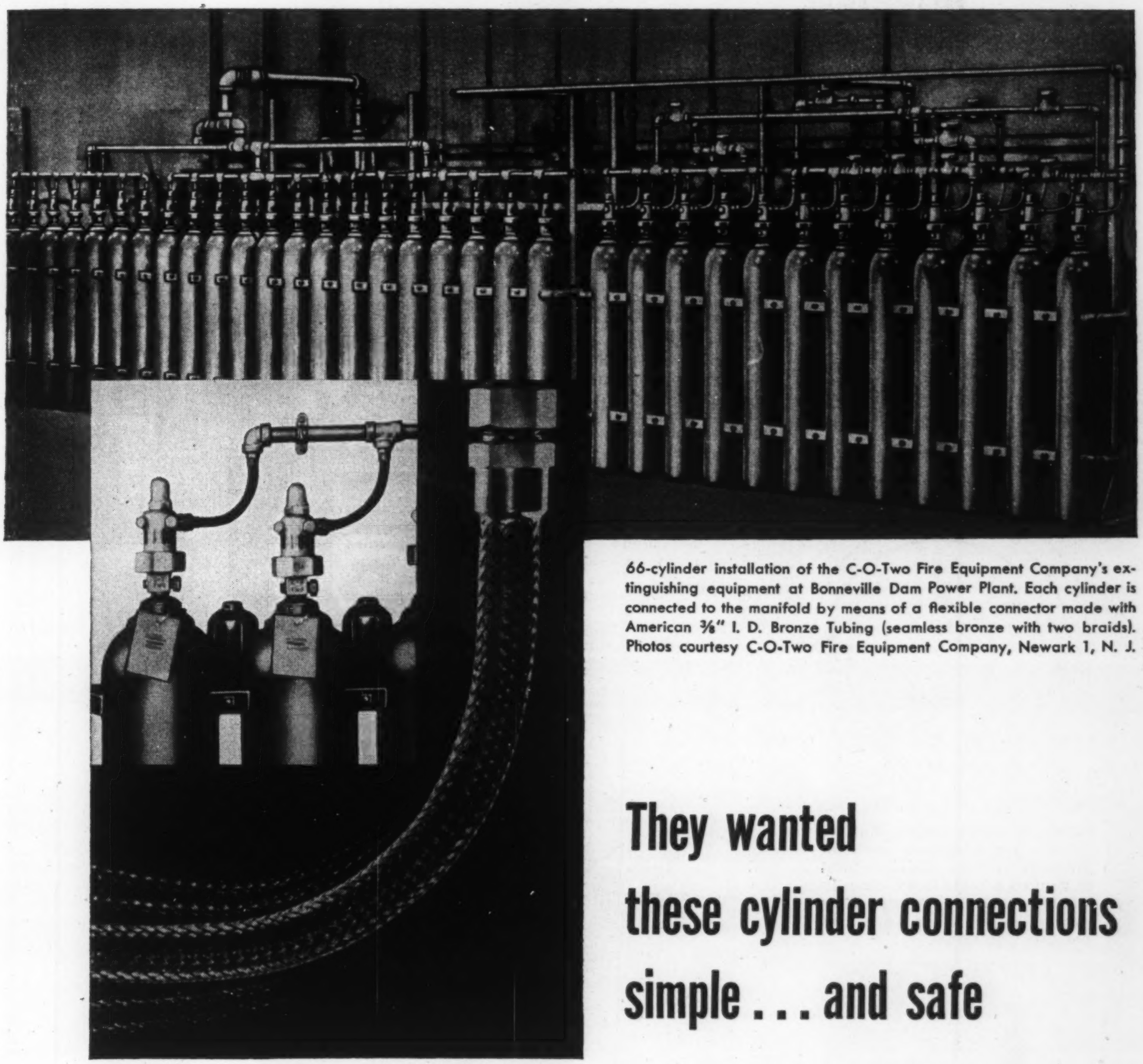
DON'T MISS "HEAT—WHERE YOU WANT IT!" Latest sound slide-film in the *MORE POWER TO AMERICA* series depicts case histories of the above five basic applications of electric heat. Ask your local power company representative or contact the nearest G-E Sales Office.

BEFORE you design your electrically heated machinery or equipment . . .

BEFORE you convert existing installations . . . consult the G-E apparatus salesman who regularly calls on you or a G-E Industrial Heating Specialist . . . his recommendations will pay you real dividends in terms of more efficient heating and better designs.

*Reg. U.S. Pat. Off.

GENERAL ELECTRIC



66-cylinder installation of the C-O-Two Fire Equipment Company's extinguishing equipment at Bonneville Dam Power Plant. Each cylinder is connected to the manifold by means of a flexible connector made with American ⅜" I. D. Bronze Tubing (seamless bronze with two braids). Photos courtesy C-O-Two Fire Equipment Company, Newark 1, N. J.

They wanted these cylinder connections simple . . . and safe

So they used American Seamless Flexible Metal Tubing for the 66 manifold connectors in this installation. Couplings swing freely and accurately into line. No struggling with rigid or semi-rigid pipe or tube.

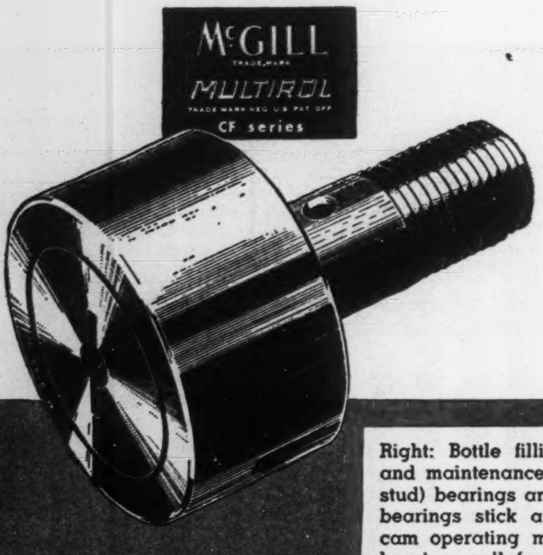
Resists corrosion, heat and cold; minimizes vibration. American Seamless Flexible Metal Tubing can be flexed thousands of times with no danger of failure—carries thousands of pounds pressure safely. For flexible metal hose or tubing designed for use with almost any gas, vapor, liquid, or even semi-solid, consult The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Company, Ltd.

49295

ANACONDA
from mine to consumer

wherever connectors must move . . . American

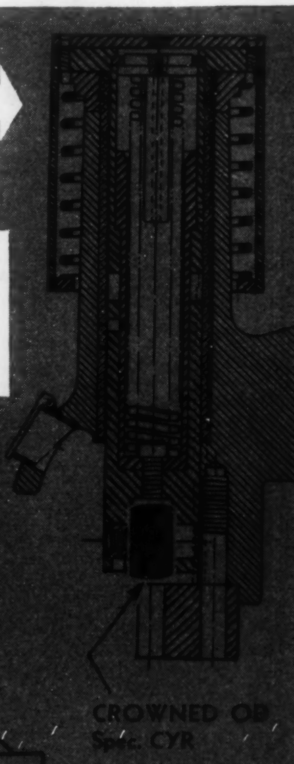
FLEXIBLE METAL HOSE AND TUBING



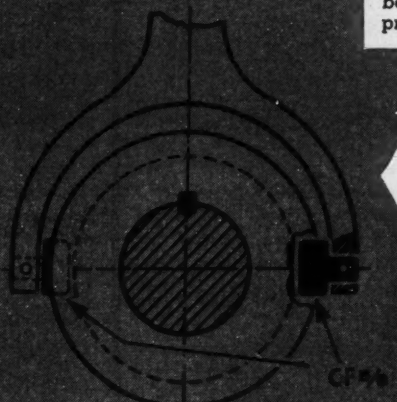
HOW TO ANTI-FRICTIONIZE WITH CAM FOLLOWERS

the MULTIROL way

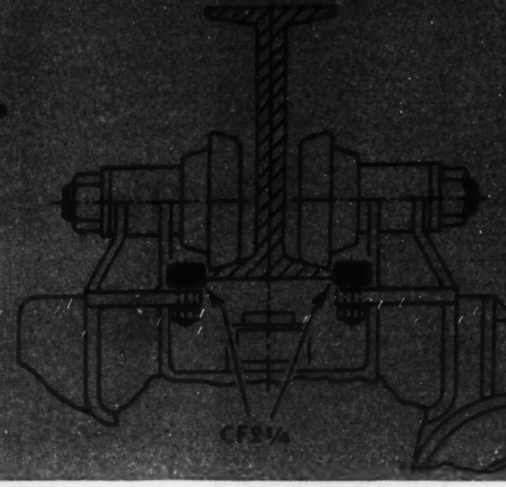
Right: Bottle filling machines require less care and maintenance when Multirol CYR Series (no-stud) bearings are used for the lifter head. Plain bearings stick and slide, causing wear on the cam operating mechanism. Multirol CYR Series bearings roll freely and smoothly and maintain proper machine adjustment.



Left: Considerable labor and costly machining is saved by using Multirol CF Series bearings in the shifting fork collar mounting. Operates smoothly and eliminates friction found in conventional bronze collar types. Stud of Multirol CF bearings threads directly to fork fingers.



Right: As guide rollers Multirol CF Series bearings for overhead Tramrail Wheels eliminate cost of flanged wheels that ordinarily wear excessively. Provide freer rolling, better alignment and positive side thrust.



Increased speeds, greater accuracy and all around anti-friction efficiency in guide and support roller applications are easily accomplished with MULTIROL CF Series bearings.

Constructed with extra heavy outer race sections to take shock load and many small diameter rollers to evenly distribute heavier radial loads . . . result is smooth performance at high speed and reduced power requirements not possible with bolt and roller units.

Lubrication is simplified with facilities provided for greasing and constant oiling and frequent adjustment due to rapid wear of plain bushings is eliminated.

Design these many anti-friction advantages into your machines with CF Series bearings for conventional stud mounting. Use the CYR Series bearings for shaft mounting without stud.

Easily applied and available in many standard sizes from conveniently located stocks. *Write today for our engineering department's helpful recommendations.*

Address McGill Manufacturing Company, Inc.
200 No. Lafayette St., Valparaiso, Indiana
for your copies of Bulletins CF-40 and CY-48

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precision bearings

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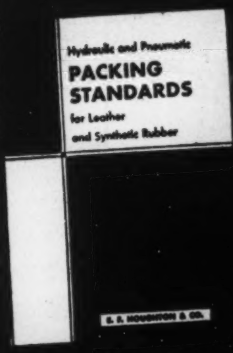


Hydraulic and Pneumatic
PACKING STANDARDS
for Leather
and Synthetic Rubber

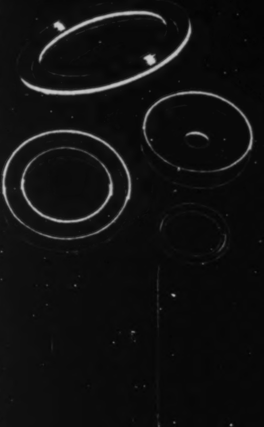
E. F. HOUGHTON & CO.

In the movement sponsored by the Joint Industry Conference to set up packing standards, reduce number of sizes and promote interchangeability, Houghton was first to prepare and distribute such simplified standards.

The booklet shown here contains tables of sizes and dash numbers for convenience in ordering. The packing industry generally and the large users have accepted these standards.

That's one valuable aid to industry from this pioneer in hydraulics. Another is the service to designers . . .

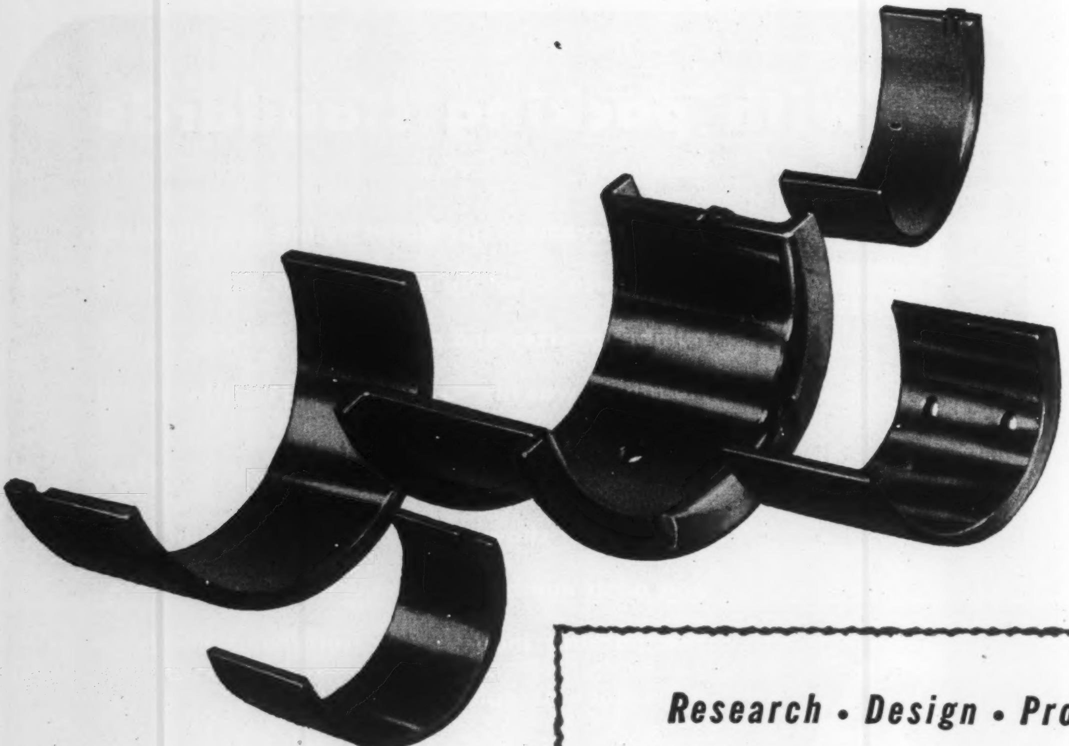
. . . with standard packings



These include leather and synthetic rubber styles —"V", "U", Cup, "O" rings and leather back-up washers.

Let Houghton make a specific recommendation on your next design and if there is trouble on a hydraulic installation due to imperfect sealing, let the Houghton engineer examine the packing set-up. A letter to E. F. Houghton & Co., 303 W. Lehigh Ave., Phila. 33, Pa., will bring results.

For "know-how" know Houghton



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FOR YOUR SLEEVE BEARING REQUIREMENTS

Complete Range of Alloys

Complete Range of Sizes

PLUS *Quality Control!*

When you specify sleeve bearings, you get the advantage of a *complete* service at Federal-Mogul, in research, engineering and production, plus 50 years of specialized sleeve bearing experience. Each of our seven manufacturing plants specializes in production within a specific range of alloys and sizes, from tiny bushings to giant bearings up to 27½″ diameter. In each plant our Quality Control group carries research and engineering quality standards into every phase of manufacture, from checking the quality of raw materials through to your finished bearing. A typical bearing, whether it is one of an order for 500 or for 50,000—will receive as many as 108 measurement checks, analysis, temperature and special tests and visual examinations before it is released for delivery. That's how fine performance is built into every Federal-Mogul *silent* sleeve bearing you receive. Whatever your requirements, *without obligation*, consult our research or engineering service.

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FEDERAL Mogul
Silent SLEEVE BEARINGS

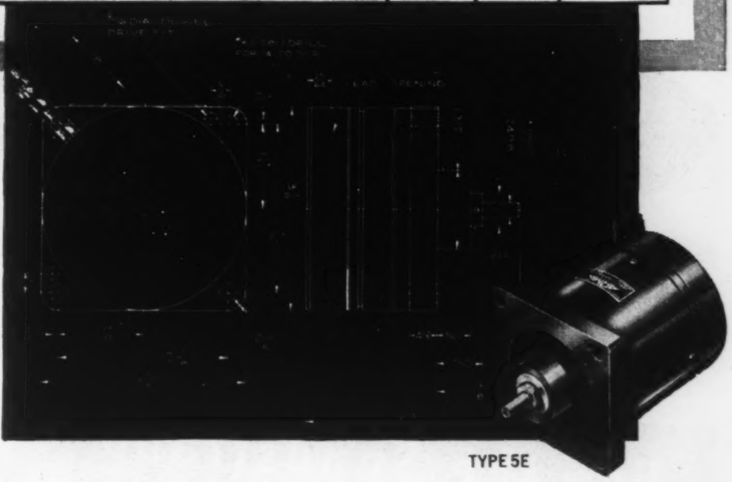
1899 – Fifty years of continuous bearing experience – 1949

To Top Flight Development, Design and Instrumentation Engineers

This table gives the essential characteristics of Arma Induction Generators. The information may suggest applications of these components to your designs.

TYPE	FREQ.	INPUT			OUTPUT			RESIDUAL AT O SPEED (m.v.)			ROTOR INERTIA Oz. In.^{2}	WEIGHT (lbs.)	ALLOW. MAX. STATIC FRIC. Oz. In.
		VOLTS	AMPS.	WATTS	Volts per 100 R.P.M.	Specified R.P.M.	Phase	In-Phase	Quadrature	Harmonic			
1A60	60	24	0.18	2.0	0.33±5%	900	0°±1.5°	10	10	10	0.22	1.5	0.2
5E	60	90	0.15	5.0	1.0 ±1%	600	0°±0.5°	5	5	15	2.60	6.3	0.75
03ADC	DC	24	0.15	3.5	0.070 V.D.C. (approx.) for an acceleration of 1400 Radians/Sec.^{2}						0.019	0.54	0.1
3	DC	38-46	0.12	5	0.1 V.D.C. (approx.) for an acceleration of 1400 Radians/Sec.^{2}						0.25	3.0	1.0

Induction Generators that serve importantly in ARMA'S Post-War Technique of electrical "BRAIN BLOCK" instrumentation



TYPE 5E

"Brain Block" instrumentation quickly describes any custom arrangement of light, small, accurate *__standard__* *Arma components to make precision instruments and controls.*

Wide Use for Tachometer Type

Arma's 1A60 and 5E Generators are of the tachometer type. They generate an A.C. voltage equal to the product of excitation voltage and rotor speed with minimum introduction of phase shift, harmonics or quadrature voltage. The linear voltage-speed characteristics of these units over wide speed ranges and the low level of quadrature and harmonics at very low or zero speed indicate their selection where a voltage proportional to speed is required. The units are designed to minimize sensitivity to temperature changes and each is calibrated and standardized for complete interchangeability. Advantages include: linearity deviations extremely small over wide speed range; minimum phase shift; and low residual voltage.

Where to Use Acceleration Type

The Arma 3 and 03ADC Generators are of the acceleration type. This type is D.C. excited and its output is a D.C. voltage proportional to acceleration of the rotor. It is extremely useful in servo systems having severe damping requirements and in systems where it is necessary to measure or limit the acceleration.

Features of Arma Ind. Generators

1. *Rugged construction and high mechanical accuracy.*
2. *Low friction and inertia.*
3. *High output to inertia ratio.*
4. *Engineered precision.*

New Opportunities in Other Arma Components, too

While you re-examine, in the light of these Generators, designs once limited by available components, it may pay you to have up to date information on: Arma Synchro Units for remote control and indicating purposes; two-phase Induction Motors for servo-mechanisms and control devices; Electrical Resolvers* for solving problems involving triangles, coordinates and vectors; high-precision Mechanical Differentials for instrument applications; D.C. Step Motors for remote control purposes; and, Induction Potentiometers for the smooth, stepless rotation required in modern "Brain Block" instrumentation.

Entering its 32nd year, Arma Corporation is so fully committed on urgent defense projects as to preclude its presently undertaking industrial instrumentation. However, you are invited to request whatever information you may need to explore the possibilities of making use of any Arma product which has been released from security restrictions.

ARMA CORPORATION
254 36th STREET, BROOKLYN 32, N. Y.
SUBSIDIARY OF AMERICAN BOSCH CORPORATION

ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

ARMA ELECTRICAL RESOLVERS* • ARMA SYNCHROS • ARMA INDUCTION MOTORS • ARMA INDUCTION GENERATORS • ARMA MECHANICAL DIFFERENTIALS • ARMA ALTERNATING VOLTAGE COMPARATOR • COMPUTING MECHANISMS • INDUSTRIAL CONTROLS • STABILIZATION DEVICES • NAVIGATIONAL EQUIPMENT • LIMITRON AUTOMATIC INSPECTION SYSTEM

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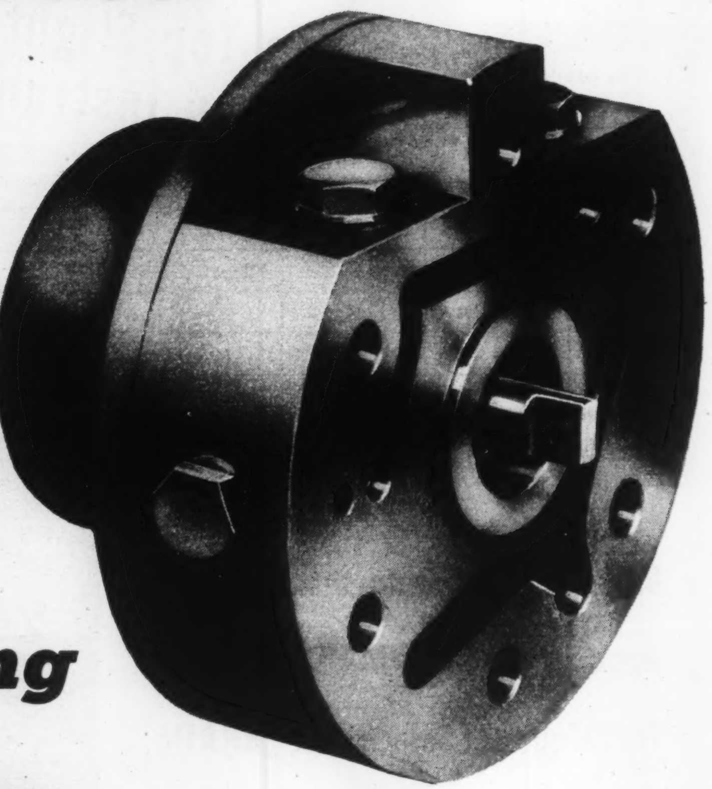
QUALITY ARMA INSTRUMENT PRECISION

When You Need
LOW COST
EFFICIENT
REVERSIBLE
Lubricating Pumps . . .



Use the Sundstrand Model 5LWX

Here's a low cost pump to use where pressure and inlet ports are fixed, but where power shaft rotation may be in either direction. Here's the pump to use in lubrication systems where power shaft rotation is reversed during the operation cycle. It has the quiet operating, efficient Rota-Roll pumping members common to all Sundstrand constant volume pumps and is precision made. An integral relief valve is incorporated in the pump for maintaining the lubricating system at the valve setting.

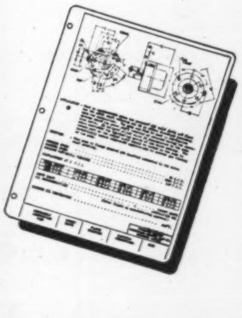
The 5LWX is flange mounted and manifold connected to the drive shaft mounting.

Available in 5 Capacities from 10 GPH to 28 GPH

The 5LWX is furnished in five different capacities of 10, 14, 16, 20 or 28 GPH at 1200 RPM. Pump is suitable for operation up to 2000 RPM and a maximum continuous pressure of 150 PSI. Pumps may be furnished with or without relief valve.

FREE
Additional Data

Write for complete data on this low cost, low pressure Sundstrand pump. Ask for bulletin M-48.



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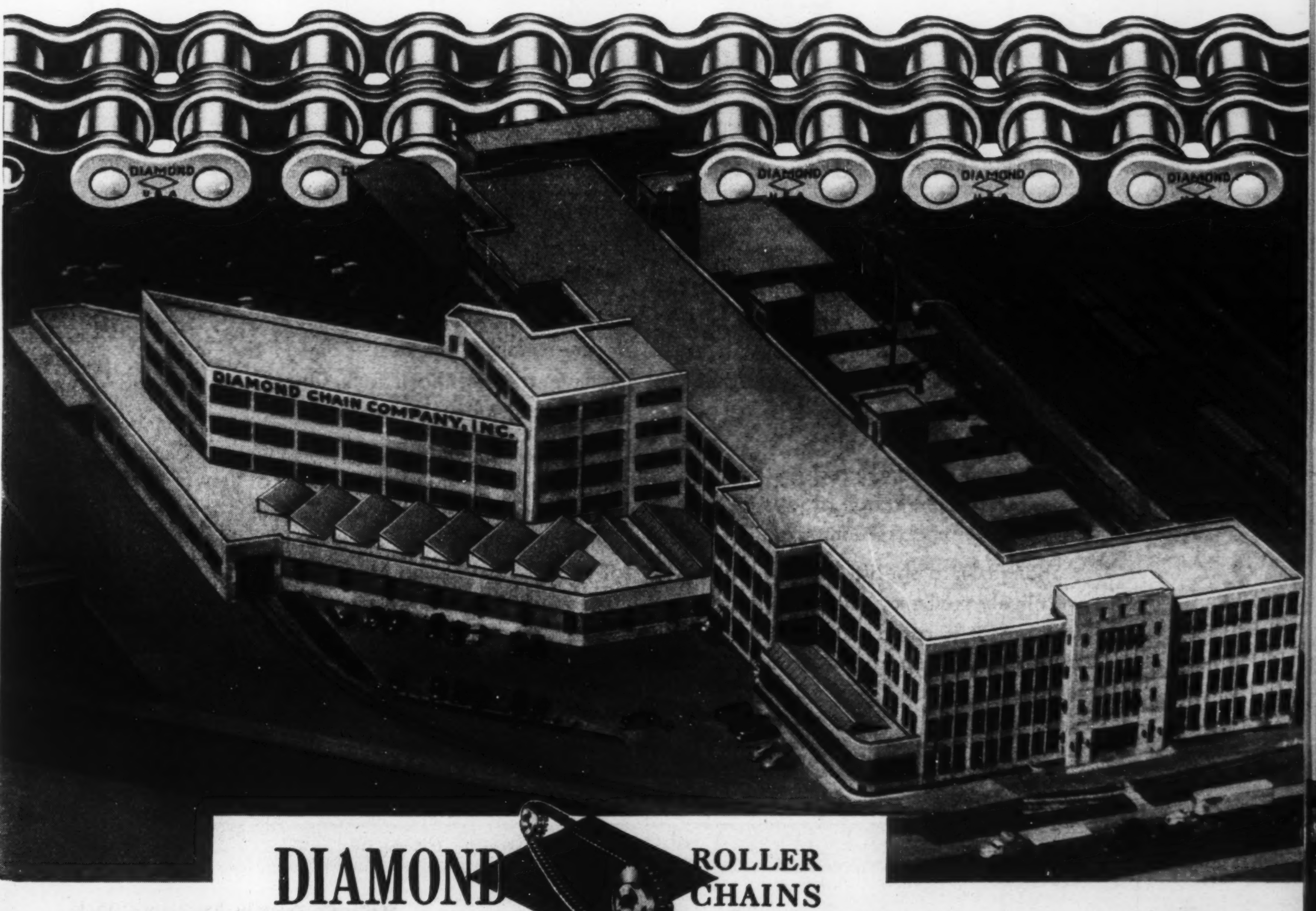
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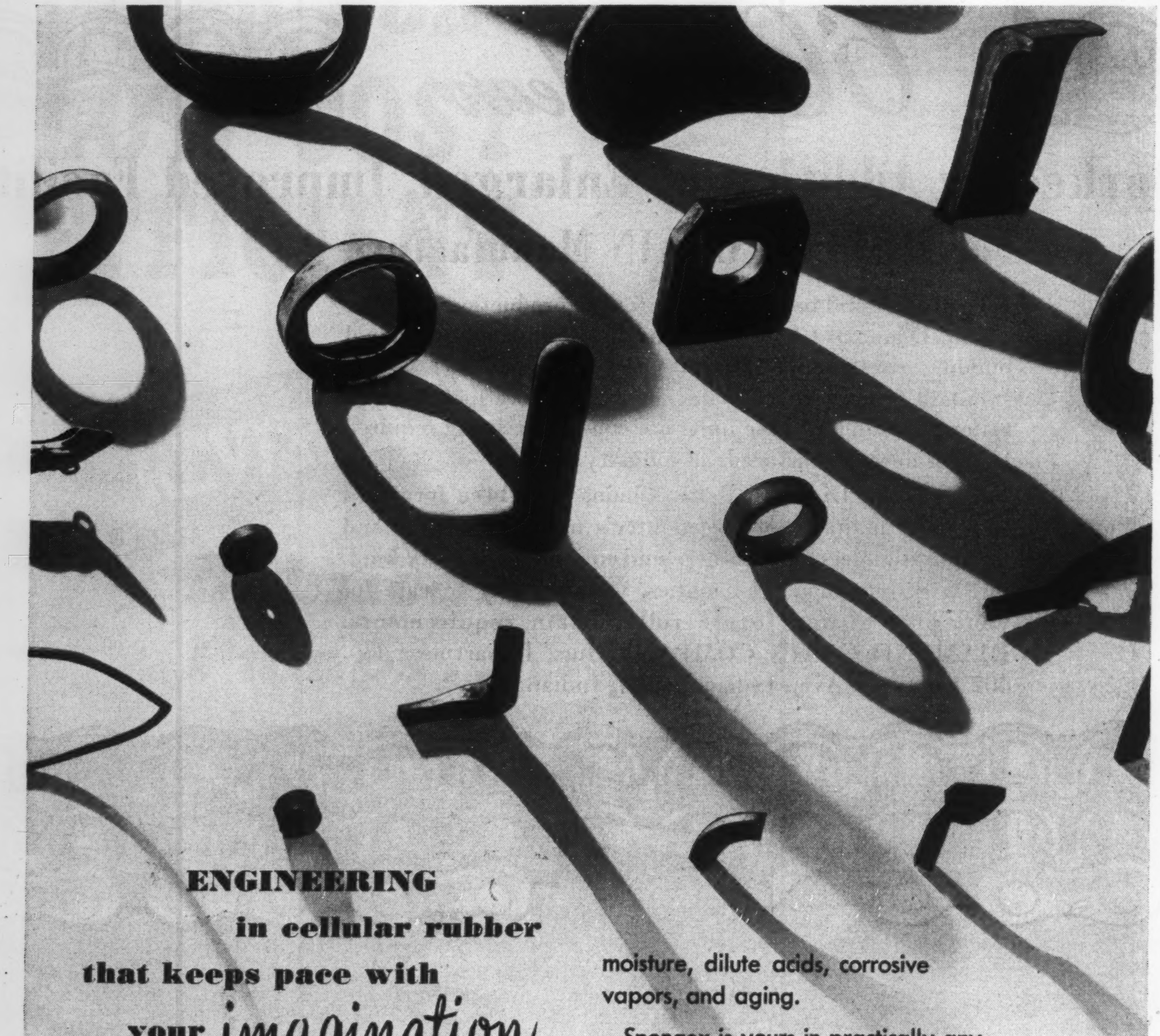
DIAMOND ROLLER CHAINS



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NATIONAL OIL SEAL LOGBOOK

CORRECT OIL SEAL DESIGN FOR OSCILLATING OR RECIPROCATING SHAFTS

Good oil seal design and construction must allow for some shaft eccentricity, shaft whip and end play—conditions which are present in all but the most precisely machined equipment. However, when shafts are required to oscillate or reciprocate, careful attention should be given to the shape and thickness of the sealing members and to correct spring tensioning.

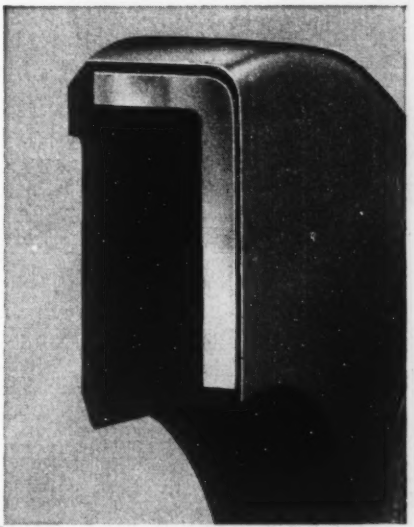

Figure 1
Syntech springless, ideal type for reciprocating shafts

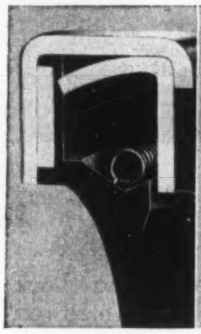

Figure 2
Syntech spring-loaded for oscillating shafts

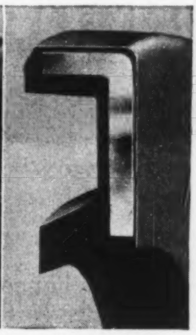

Figure 3
Syntech springless variation for reciprocating or oscillating shafts

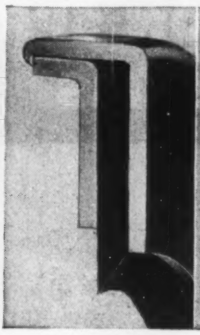

Figure 4
Springless leather dust wiper for reciprocating shafts

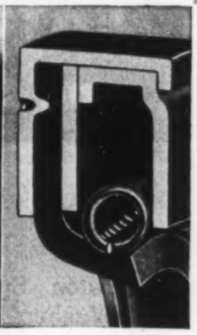

Figure 5
Spring-loaded leather for oscillating shafts

In the case of reciprocating shafts it is usually better to utilize a springless Syntech type oil seal with heavy straight lip sealing member. Limited contact seals should be avoided because the sealing members are apt to buckle or fold over under the quick reversals of shaft movement. The National Syntech oil seals shown in Fig. 1 and 3 with heavy Syntech sealing member section provide excellent performance on reciprocating shafts. Springless type leather (Fig. 4) seals are ideal as auxiliary dust wipers on reciprocating shafts.

The oscillating shaft does not pose as difficult problems as those encountered with reciprocation. However, care should be exercised in providing rugged sealing members that maintain somewhat broader contact with the shaft. If spring-tensioned seals are required, tensioning should be adjusted in order to prevent buckling.

National engineers have been successful in helping solve many difficult and exacting problems of sealing around oscillating and reciprocating shafts. New National Syntech* (synthetic rubber) sealing members (Fig. 1, 2 and 3) which can stand extreme temperatures; specially impregnated (Nationalized) leather sealing members (Fig. 4 and 5) and precisely manufactured oil seal cases have been utilized. This experience is available to you at any time without cost or obligation.

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OIL AND FLUID SEALS ®

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Plants: Redwood City and Los Angeles, Calif.; Van Wert, Ohio

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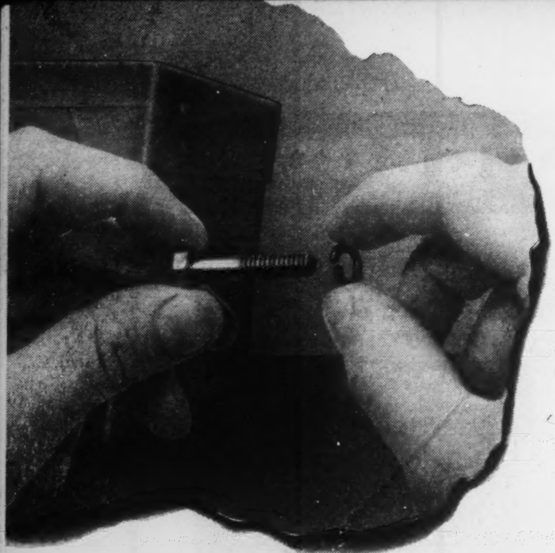
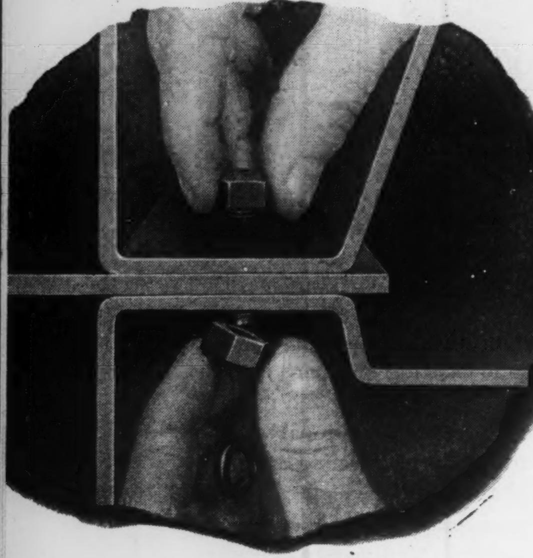
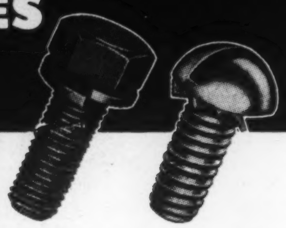




Eliminate Practices from your assembly line fastening picture with EATON SPRINGTITES and SEMS



Eaton Springtites are quality Reliance Spring Lock Washers of correct type and size pre-assembled on quality bolts and screws so they *can't come off.* The shank diameter fit of the Reliance Spring Washer on screws or bolts is so designed as to give the spring lock washer freedom of movement to rotate and act as a hardened thrust bearing, allowing greater torque in tightening the screws and bolts in the assembly.

Eaton Springtites eliminate assembling of lock washers on screws or bolts before they can be used—*save time and money.*

Eaton Springtites eliminate the chance of a bolt or screw being used in an assembly without a spring lock washer or with the wrong type or size spring washer—*protect your product and its performance.*

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RELIANCE SPRING LOCK WASHERS . . . An effective fastening device made to insure dependable, enduring bolt tightness. A type and size for every fastening need. Write for folder.

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Job File No. 1949

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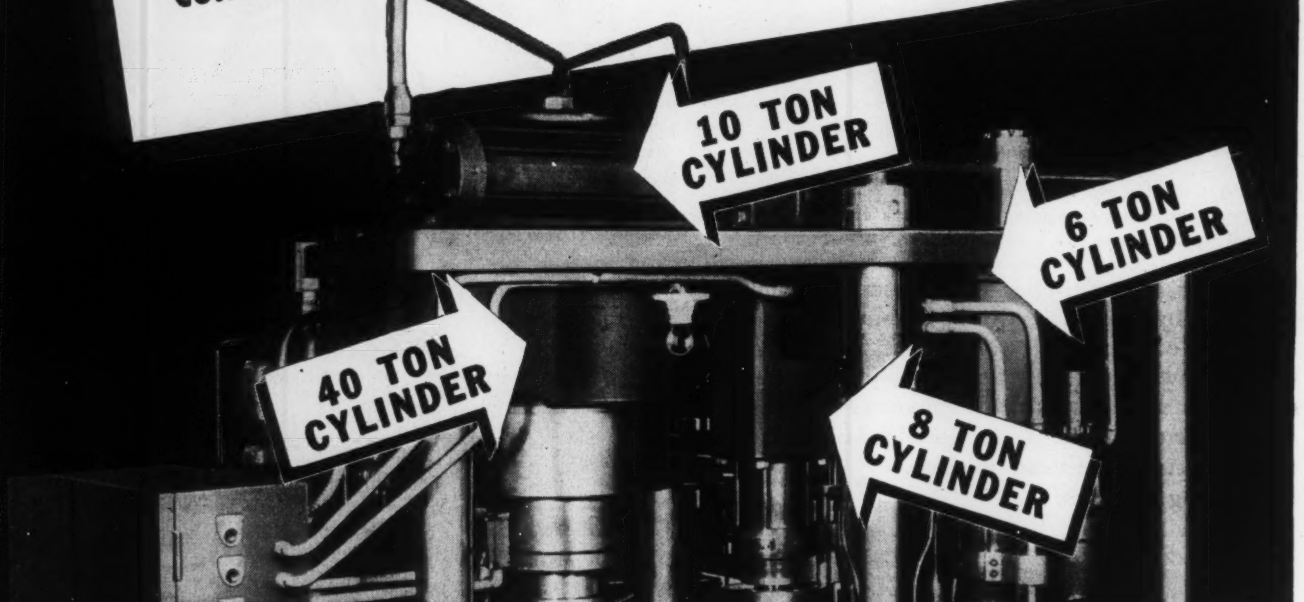
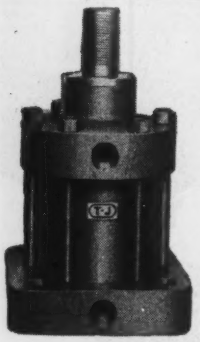
CONTROLLED BY T-J CYLINDERS



All moving parts are controlled hydraulically by T-J Cylinders —on this Malleable Nut Production Machine designed and built by Roy Hays & Associates, Rockford, Ill., for the Wagner Malleable Products Co., Decatur, Ill.

It's *fully automatic*—the operator only places nuts in stations. Nine T-J Cylinders, 40 ton to ½ ton, help complete the job of cutting off sprue, sizing, boring, facing, chamfering and threading 2,500-¾ std. pipe thread nuts per hour.



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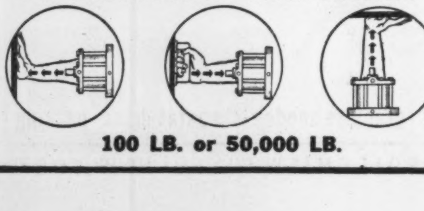

100 LB. or 50,000 LB.

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T-J

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Production Men Have Found the Answer to Better Motor Performance

There's no magic to it—just a motor that's built the way production men *want* their motors built. And more and more spec sheets carry the message "DELCO PREFERRED" to take advantage of the extra care and extra features that make Delco motors outperform all others. Here are a few of these *performance extras:*

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- **Dynamically-Balanced Rotor and Shaft Assembly**
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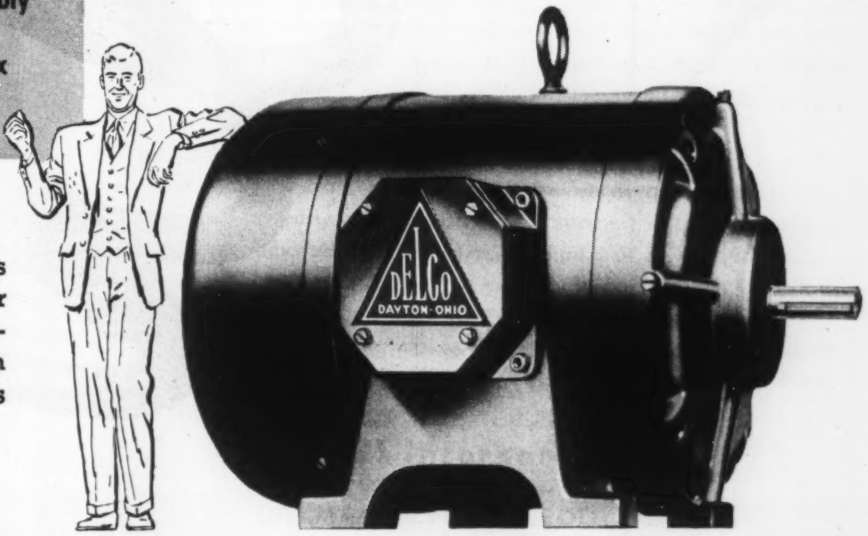

Why not get all the facts on Delco motors? Phone or write Delco Products, Dayton, Ohio . . . or get in touch with one of the sales offices listed below.

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DELCO PRODUCTS, DIVISION OF GENERAL MOTORS CORPORATION, DAYTON, OHIO

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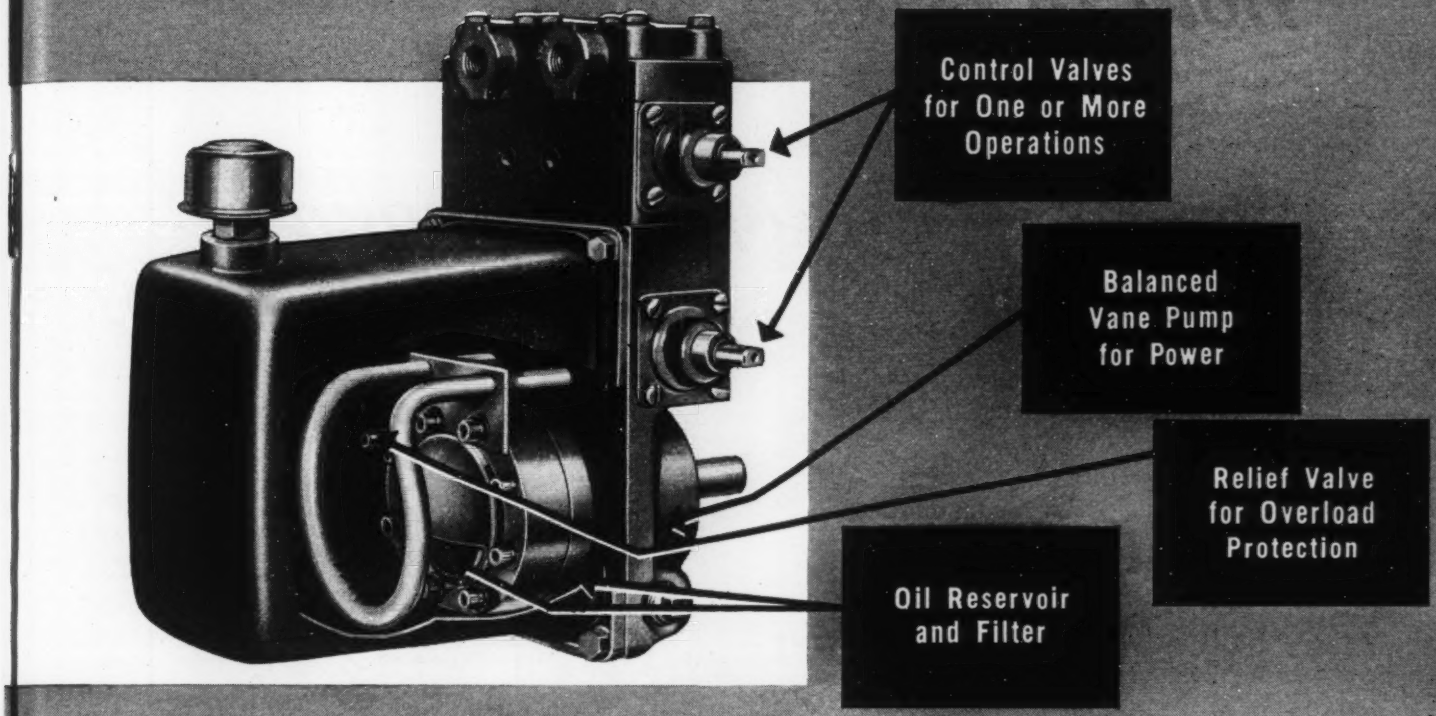
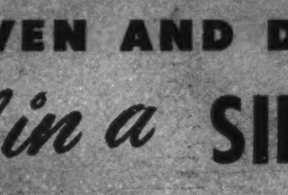
VICKERS *Hydraulic* POWER PACK



PROVEN AND DEPENDABLE HYDRAULIC POWER

All in a SINGLE, COMPACT PACKAGE

It will
PUSH, PULL
LIFT, LOWER
or HOLD
at a Finger-Touch



The Vickers Hydraulic Power Pack has a number of important advantages over the ordinary hydraulic pump that recommend it to equipment manufacturers and users alike. For example: the included Vickers Vane Pump is hydraulically balanced to eliminate bearing loads resulting from pressure and assure long and trouble-free service life. It has automatic wear compensation, and ideal running clearances are always maintained. All continuously moving parts are contained in pump cartridge which is easily removed without disturbing piping or drive coupling.

Overload protection is automatic and foolproof through a built-in relief valve. Operators can work fast and crowd hard without fear of damage. Universal mounting makes for quick, easy installation. Bulletin 46-48 explains the many other advantages of the Vickers Power Pack; ask for a copy.

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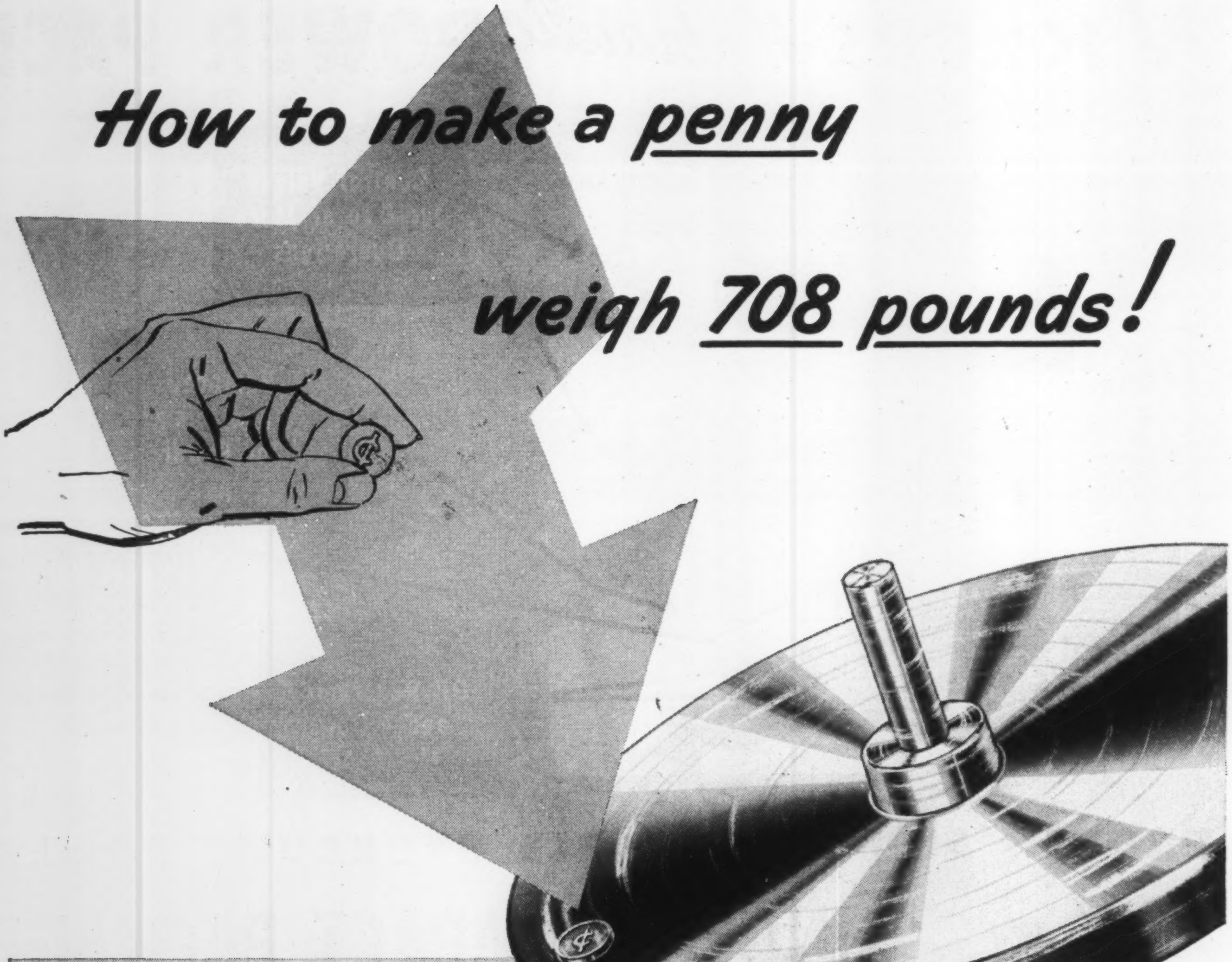
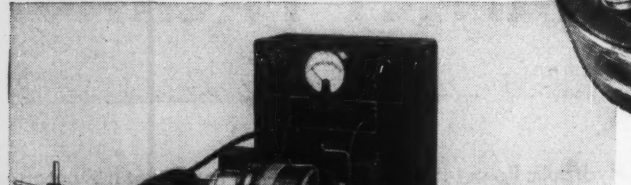
BULLETIN
46-48

Vickers Hydraulic Power Pack is Saving Labor and Reducing Costs on Agricultural Implements, Construction Machinery, Materials Handling Equipment, and Industrial Machinery

How to make a penny weigh 708 pounds!





The Gisholt DYNETRIC 3S Balancing Machine shown above is one of many sizes and types available to handle parts weighing from a fraction of an ounce to many tons. Write for literature on the complete line of "S" machines.

Yes, one of those little coppers in your pocket can exert enough "pull" to amaze you.

It's simple dynamics—centrifugal force. To start with, it weighs only ⅛ ounce. Put this "unbalance" weight on a rotating body at 6″ from the center and let's see what happens. At 500 r.p.m. it exerts a force of .44 pound. Now, speed it up. The centrifugal force increases as the square of rotational speed. At 5,000 r.p.m. it becomes 44.25 pounds. At 20,000 r.p.m. the ⅛ ounce becomes a force of 708 pounds on the restraining bearings. Such unbalance in rotating parts causes vibration. And that means trouble in high-speed rotating assemblies—excessive wear, shorter life.

That's why it's so important to specify *accurate* static and dynamic balance in such parts—as a part of design. It's just as important as your specifications for materials and manufacturing tolerances.

World-wide leadership in the field of balancing makes Gisholt your most practical source for help on all balancing problems. Write us.

DYNETRIC BALANCERS GISHOLT

DEVELOPED JOINTLY WITH WESTINGHOUSE ELECTRIC CORPORATION
"DYNETRIC" IS A TRADE MARK REG. U. S. PAT. OFFICE BY WESTINGHOUSE ELECTRIC CORPORATION

GISHOLT MACHINE COMPANY
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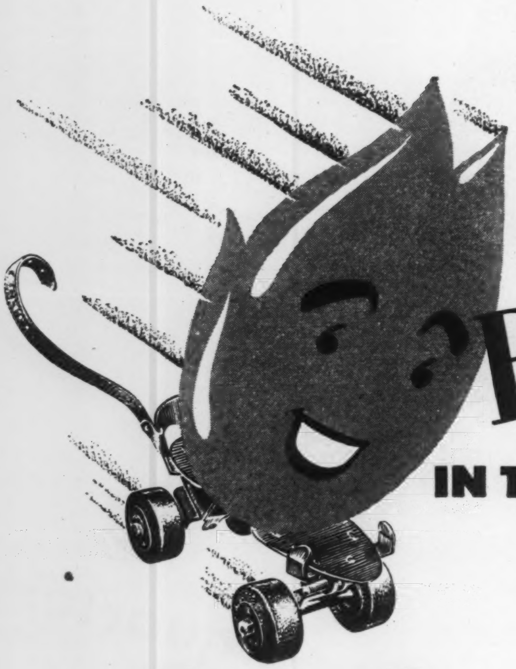
Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers



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★ Whether or not you have made a recent heat consumption survey, why not consult a Ross heat exchanger engineer now? No obligation in finding out from him how to increase the B. T. U. return from every fuel dollar you spend.

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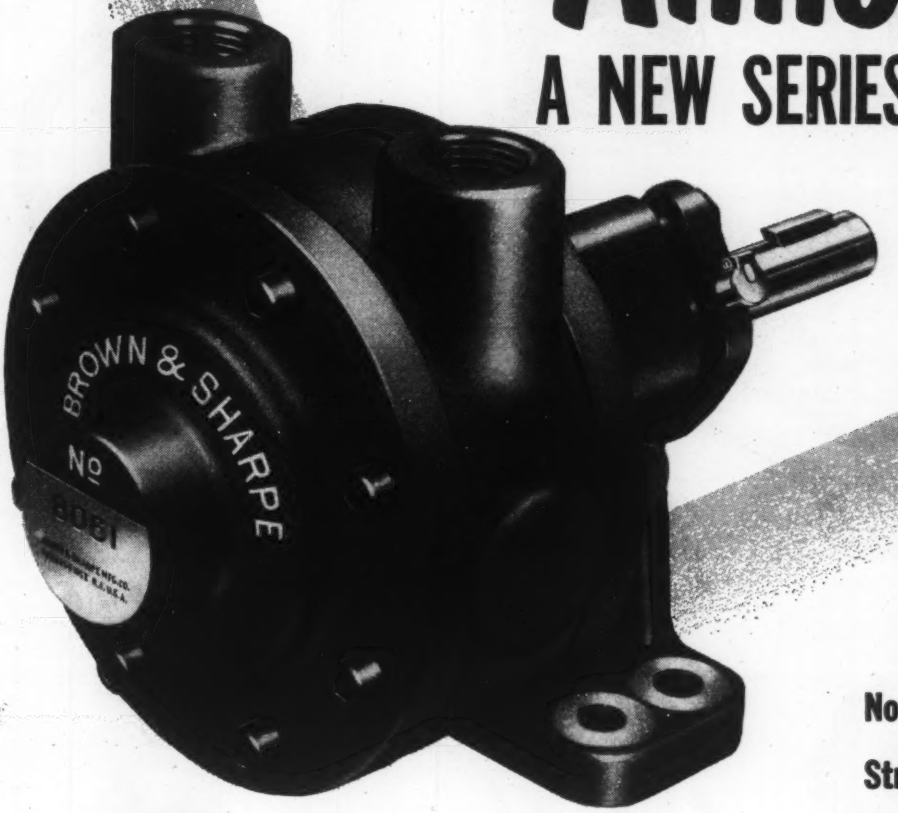

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Nos. 8021, 8061, 8101 – and

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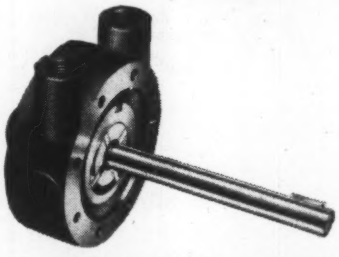

Stripped Models with Housings, Nos. 8022, 8062 and 8102. Simplify installation, particularly where internal discharge and suction ports are not readily incorporated in the machine design, or where outside piping is desirable.

Stripped Models without Housings, Nos. 8023, 8063 and 8103. Made for manufacturers who wish to utilize pumps as integral parts of machines with suction and discharge ports incorporated in the machine castings. Provides compact installation . . . minimum projection from machine surfaces.

Many important and convenient features have been designed into this New Series of Brown & Sharpe Pumps for lubrication and coolant systems on machines that reverse. Heading the list is the fully-automatic reversing feature with unidirectional flow. Other features include . . . three sizes—2½, 5 and 11½ gpm at 0 pressure, max. speed 1140 R.P.M. . . . easy changeability of flow direction from one port to the other, in the field . . . mounting design that permits foot to be set in 4 different positions with ports held vertical.

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Bundyweld, made of steel, Monel, or nickel, is double-walled from a single strip, and copper-bonded throughout . . . for extra-strong tubing that's lightweight, ductile and leakproof, too. It can be bent without fear of its weakening or collapsing structurally, and is easily fabricated.

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4 Bundyweld comes in standard sizes, up to ⅝" O.D., in steel (copper or tin coated), Monel or nickel. For tubing of other sizes or metals, call or write Bundy.

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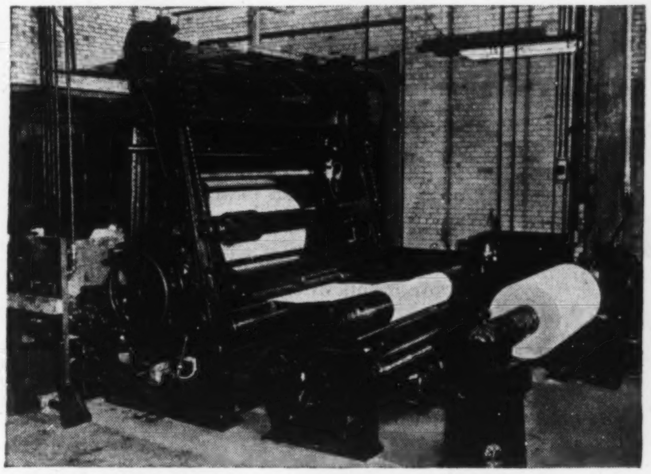
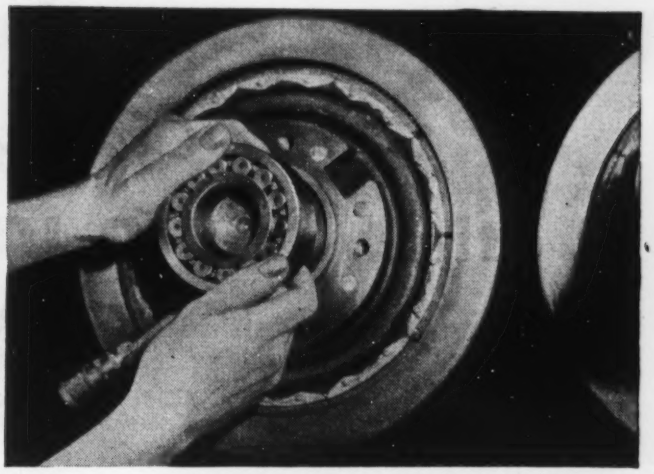
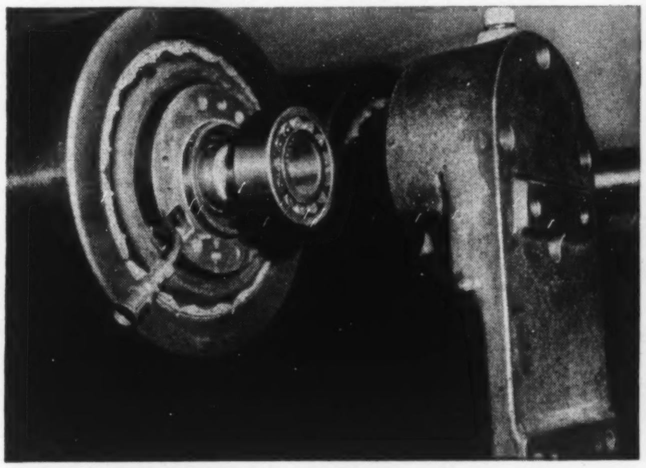
Torrington Spherical Roller Bearings maintain roll accuracy and alignment in CAMACHINE slitting and winding units



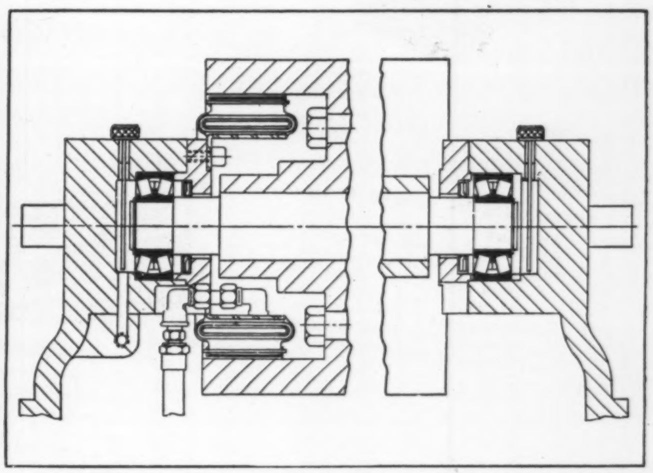
Modern paper converting machinery must be fed from uniform paper rolls. The Cameron Machine Company, Brooklyn, New York, has specialized for more than 43 years in the manufacture of slitting and winding machines, such as the Camachine 18 shown above, that will produce clean-edged, even wound rolls.



An important engineering feature of all Camachines, that assures even tension on the web and smooth, even winding, is the use of Torrington Spherical Roller Bearings on all through shafts. Despite center distances as high as 162", these self-aligning bearings make it easy to secure accurate alignment of shafts.

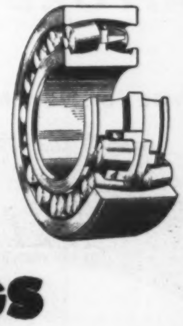


On idler rolls, above, Spherical Roller Bearings turn freely, with minimum friction, under the weight of heavy paper reels. They compensate automatically for deflection. Since the bearings cannot bind or drag, they provide insurance against a torn or twisted web, and reduce power requirements to a minimum.



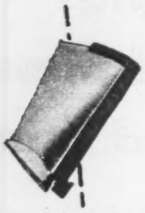
Cross-section of an idler roll shows the application of two of ten Spherical Roller Bearings used in the Camachine 18. The angular location of the rollers with reference to the bearing axis provides thrust capacity and eliminates end play, another important feature in producing even paper rolls.

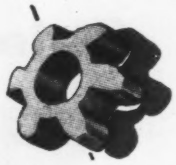
Wherever shaft deflection or misalignment is a problem in heavy-duty equipment, the free-rolling self-alignment of Torrington Spherical Roller Bearings assures long service life with minimum maintenance. Let our engineers help you with specific design problems. THE TORRINGTON COMPANY, South Bend 21, Ind., or Torrington, Conn. District offices and distributors in principal cities of United States and Canada.



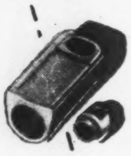
TORRINGTON SPHERICAL ROLLER BEARINGS

Spherical Roller • Tapered Roller • Straight Roller **Needle • Ball • Needle Rollers**





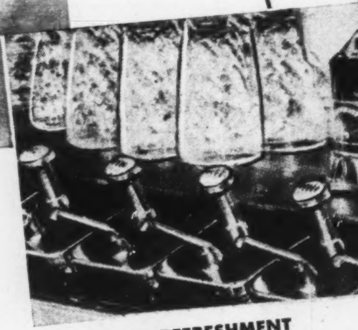
Small Castings that do BIG JOBS



Forward-looking design engineers find that Microcast, for small components, offers many opportunities for product improvement and substantial savings in cost. This is particularly true where resistance to wear or corrosion is desired or where the part is of intricate shape, requiring expensive machining operations under conventional production methods.

With the Microcast Process, the unusual properties of the extremely hard, high-melting-point alloys can be used to full advantage. Small components of intricate shape, as cast, are dimensionally uniform, of sound structure, and to such close tolerances that little or no machining is required.

SPECIALISTS IN POWER BLADING
The "guts" of any turbine-type power development unit is its power blading. The Microcast Process has produced millions of these blades, utilizing the high-melting-point, non-machineable alloys at substantially lower costs than other methods of manufacture.



TIME FOR REFRESHMENT
When you step up to your favorite fountain chances are the syrup for your soda, pumps through a Microcast dispensing part. What's important is that these 18-8 stainless steel Microcastings resulted in considerable savings in die and machining costs over previous production methods.

IT AIN'T HAY
At least the operation is not complete until the modern hay baler goes into action! A Microcast gear on the knotter twine disc assembly eliminates the costly milling and hobbing operations ordinarily required to form teeth.

Microcastings... IN A WIDE VARIETY OF PRODUCTS AFFORD BETTER PERFORMANCE AT LOWER COST

Write for New Microcasting Booklet

MICROCAST

MICROCAST PROCESS
PRECISION CASTINGS

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More complete information on Microcast is contained in a new 16-page booklet published by Austenal Laboratories, Inc., originators of the Microcast Process. The booklet describes many applications for Microcasting and also explains the process itself. Write for your copy today.

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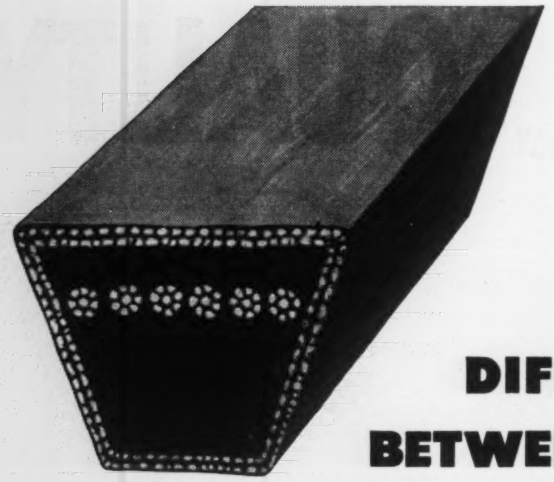
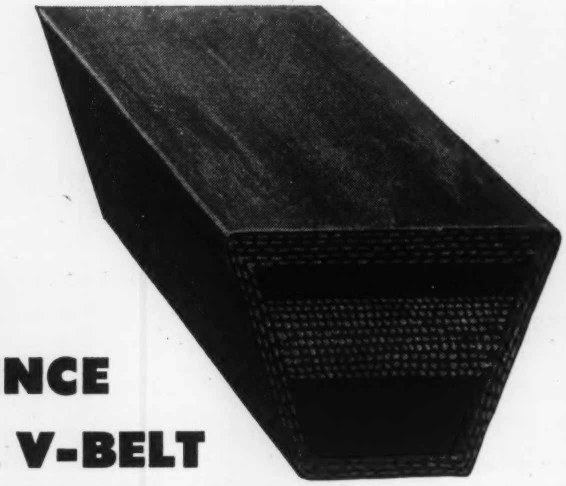




THE DIFFERENCE BETWEEN A V-BELT AND A MACHINE PART

A V-Belt can be thought of as just that much belt. But if you think of its essential part in the machine's whole economic and production function, then you want only the kind of belt that provides for the load as compactly as possible, runs smooth, conserves power, safeguards steady output—*and keeps on doing those things.*

Gilmer V-Belts make good on all those counts, for strictly tangible reasons—one big reason being Gilmer Rayon Pulling Cords. They fit in with modern engineering design because they don't need bulk to be strong. Therefore they are positively locked and cushioned all around, even in Gilmer V-Belts of limited cross-section. You get negligible internal cord friction, despite short centers and sharp flexing. Since these high-strength Gilmer Rayon Cords are fully controllable when made, and then specially "normalized," you get matched V-Belts that stay matched.

Now look into all the other Gilmer V-Belt features—below. They add up to more than belt improvement; you improve the whole machine, the drive, *and the cost components*, by applying Gilmer V-Belts—made in all standard and numerous special sizes listed in the Gilmer Mold List. Ask for book 135.

GILMER FHP V-BELTS

Straight Sidewalls: **contact with groove walls the full height of the side assures maximum grip.**

Strong Rayon Single Strand Pulling Cords: **"normalized" against stretch and fatigue.**

Deep Cushion Rubber Section: **preserves grip, cross-section and coolness.**

Double Jackets: **for lasting anti-slip grip and internal protection.**

GILMER SUPER-SERVICE BELTS

Nylon Pulling Cords! Neoprene body! Most revs per dollar!

NOW—ZERO SLIPPAGE with Gilmer "Timing" Belts®

The engineer's dream fulfilled by Gilmer! . . . Belt drive fully as smooth and positive as any transmission known . . . Now made possible by the flat, endless, steel-corded Gilmer "Timing" Belt, with teeth engaging axially-grooved pulleys, for perfectly synchronized speeds. You can make radical improvements in transmission layouts. Write Gilmer for details.

Flat belts for original equipment manufacturers are covered in the New Gilmer Belt Catalog. Just out. Ask for your copy.

GILMER MULTIPLE V-BELTS

Straight Sidewalls: **contact with groove walls the full height of the side assures maximum grip.**

Locked Rayon Ply Pulling Cords: **brute strength without friction effects.**

Top and Bottom Rubber Sections: **expertly balanced to make a cool flexing belt.**

Sturdy Jackets: **resist wear and slip; guard the belt's interior.**

Controlled Stretch: **special cord processing preserves matched lengths.**

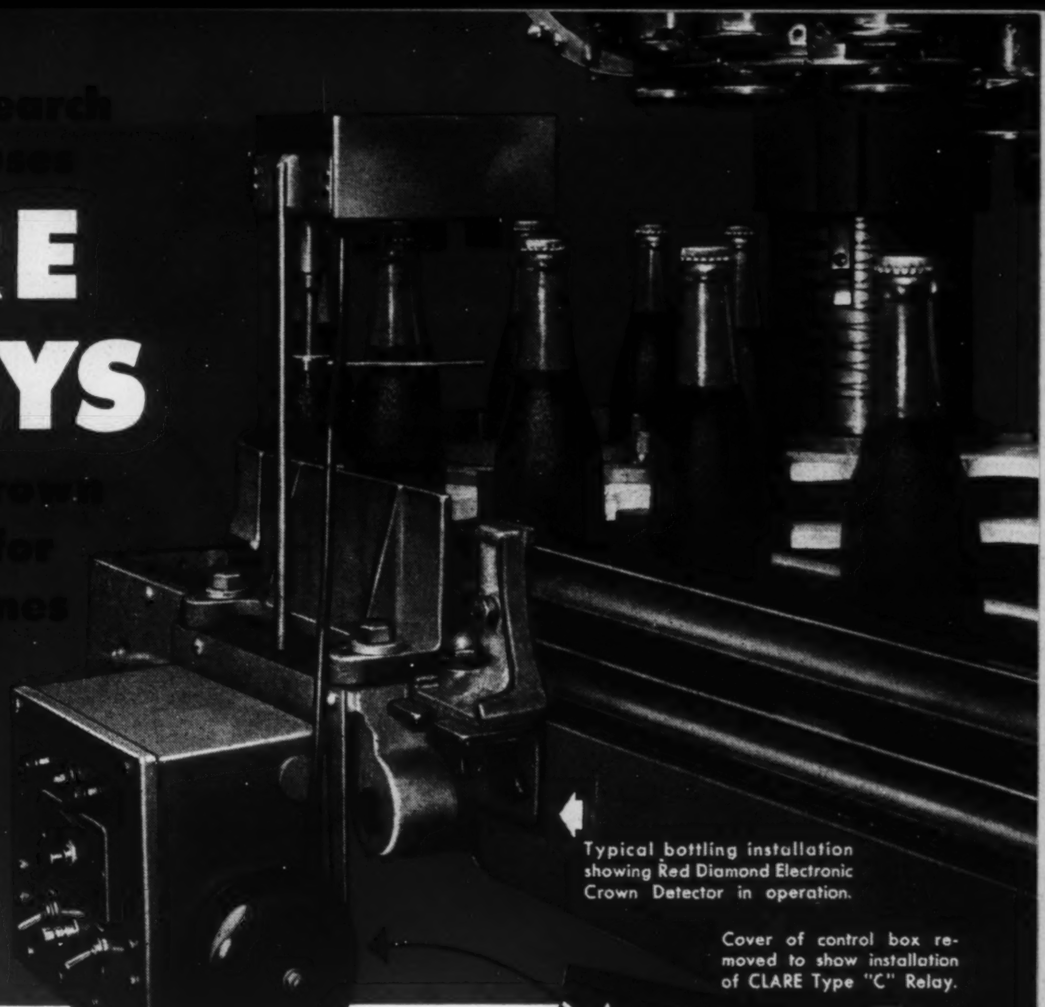
Gilmer has the Pull

L. H. GILMER COMPANY Division of United States Rubber Company **Tacony, Philadelphia 35, Pa.**

Industrial Research Laboratories uses

CLARE RELAYS

in Electronic Crown Detector Unit for Bottling Machines

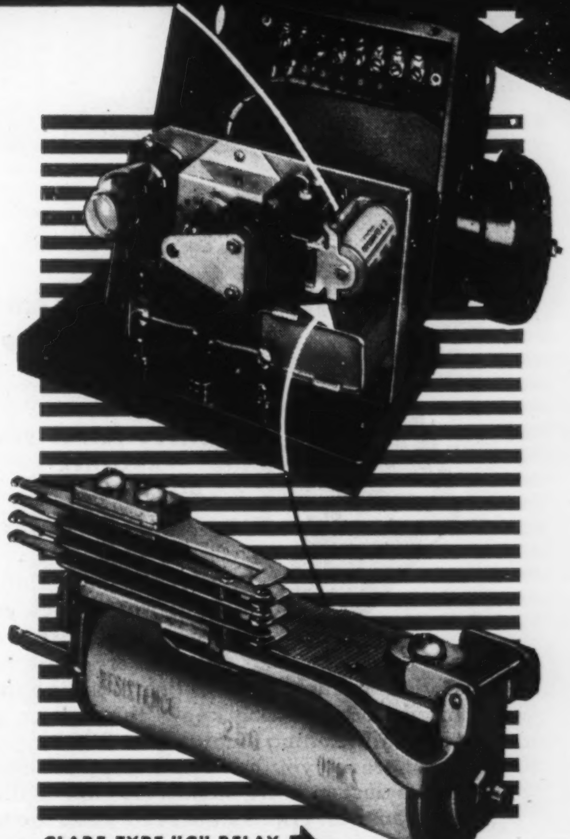


Typical bottling installation showing Red Diamond Electronic Crown Detector in operation.

Send for CLARE Engineering Data Book

This book, sent on request, pictures and describes the complete CLARE line of relays and allied control apparatus to meet the widest variety of industrial uses.

Cover of control box removed to show installation of CLARE Type "C" Relay.



CLARE TYPE "C" RELAY

This electronic device warns of any interruption of the crown supply in bottling operations. It is sold by Liquid Carbonic Corporation of Chicago and manufactured by Industrial Research Laboratories of Baltimore, Md.

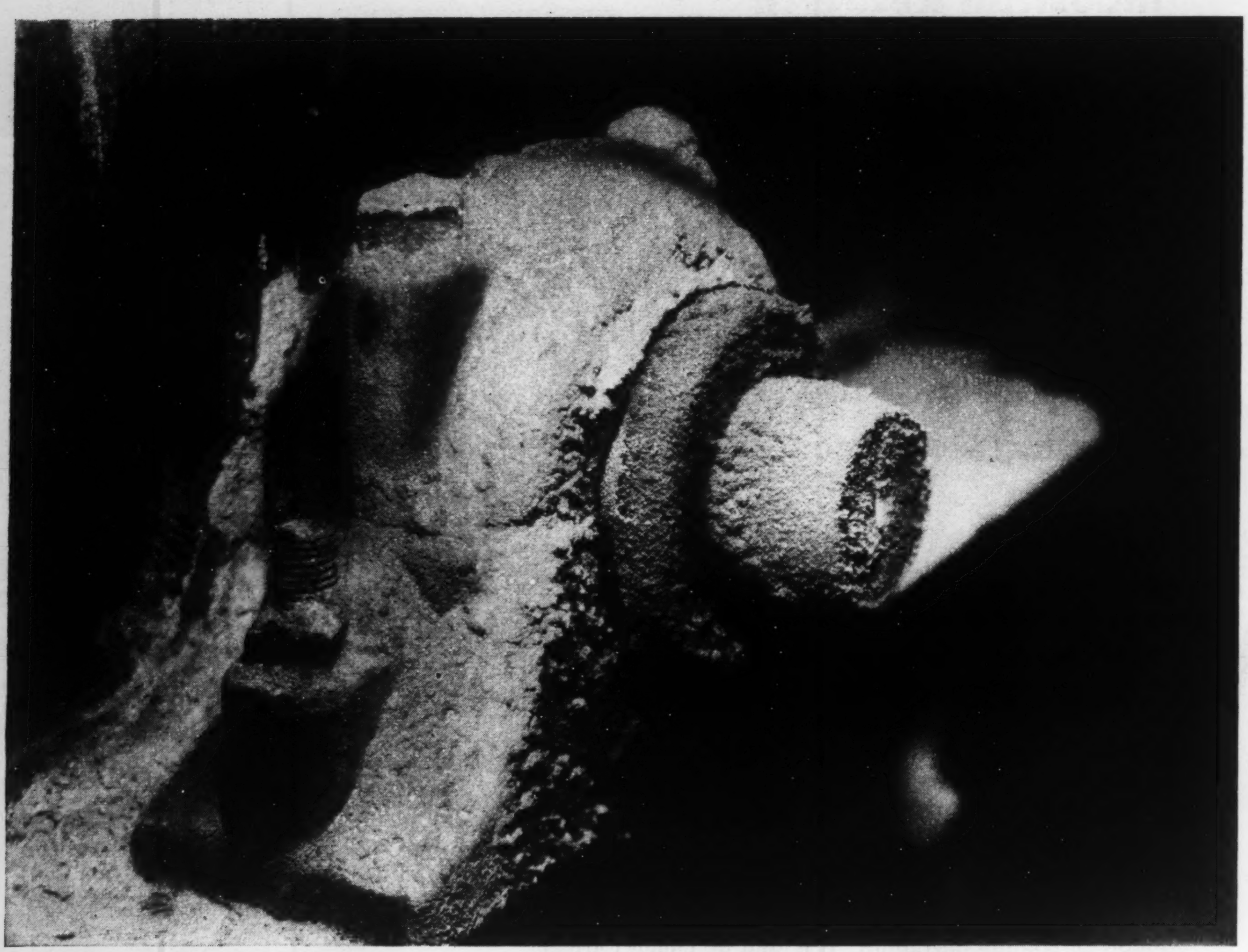
A bottle feeler switch is inserted in the control grid circuit to close the circuit when a bottle passes between the poles. If a crownless bottle passes, an electronic tube momentarily operates the CLARE Type "C" Relay and an alarm sounds for a few seconds. Passage of the second crownless bottle causes the CLARE relay to stop the machine on the second operation.

CLARE relays were selected by Industrial Research Laboratories for this important operation because of their long reputation for accurate, long-life performance as components of devices designed for trouble-free operation, day in and day out. In larger plants, more than a million bottles per week pass through the machine.

If you have a difficult relay problem, a requirement where ordinary relays just won't do, why not take it up with our engineers? CLARE sales engineers are located in principal cities. They are experienced in the most difficult types of relay problems. We invite you to take advantage of their services. Call them direct . . . or write to C. P. Clare, 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable address: CLARELAY.

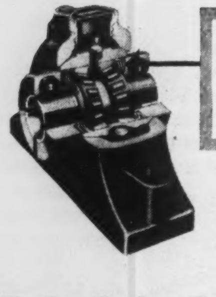
CLARE RELAYS

First in the Industrial Field



DEFIES ABRASIVE DUSTS!

The Famous Dodge-Timken Type C Bearings in Your Plant Assure Uninterrupted Production



POSITIVE TRIPLE SEAL
—ANOTHER DODGE "FIRST"

WHEN you grind steel, cement, iron or rock you get dust — powdery, abrasive dust that seeps everywhere—except into Dodge-Timken Type C bearings like the one pictured above, which keeps the mill on which it is installed running smoothly at 3000 r.p.m.!

Wherever you have operating conditions of extreme dust and dirt, standardization on the Type C is your answer. Triple steel seals keep the lubricant in and the dirt out of this bearing, and in thousands of installations Dodge-Timken Type C pillow blocks are operating successfully under adverse conditions where other bearings failed. Rugged in construction, fully self-aligning, with both radial and thrust carrying capacity, Type C is suitable for heavy line shaft service as well as many machine applications.

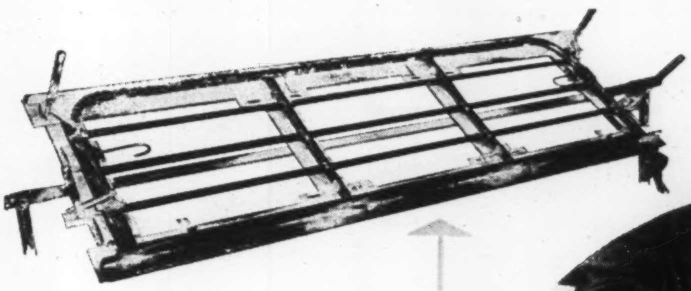
For complete information concerning this bearing and other Dodge "Firsts" in power drive equipment call a Transmissioneer—your local Dodge Distributor. Look for his name under "Power Transmission Equipment" in your classified telephone directory.

DODGE MANUFACTURING CORPORATION, MISHAWAKA, IND.

DODGE
of Mishawaka, Ind.

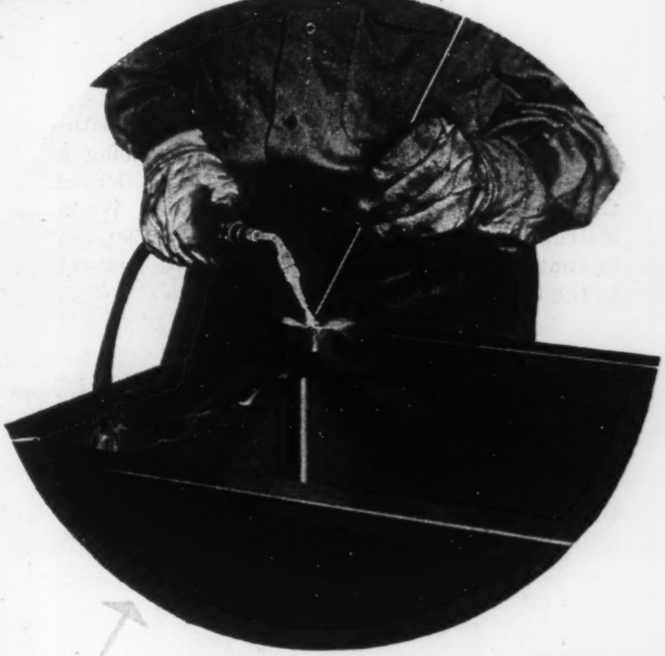
The Transmissioneer is a graduate of an intensive training course at the Dodge factory. He can help you find the answer in applying power to the job.

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY,
ETCHING COMPANY OF AMERICA 1520 MONTANA STREET, CHICAGO 14, ILLINOIS



Safety slide for hospital bed. 42 half-inch long tack welds plus 6 continuous welds are made on .042" cold rolled steel in 23 minutes, including assembly time.

Simmons STEEL FURNITURE *is Bronze Welded*



Bedside cabinet. 2 reinforcing welds, 2 inches long, are made on 20-gage cold rolled steel in 54 seconds.

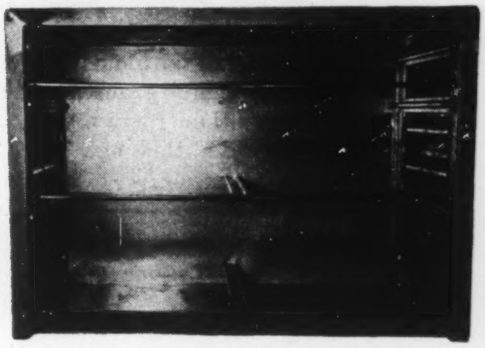
PRODUCT IS STRONGER

ASSEMBLY IS FASTER

COSTS ARE LOWER

COMPARATIVE SAVINGS:
Using ANACONDA 997 (Low Fuming) Bronze versus steel welding rod on same operations

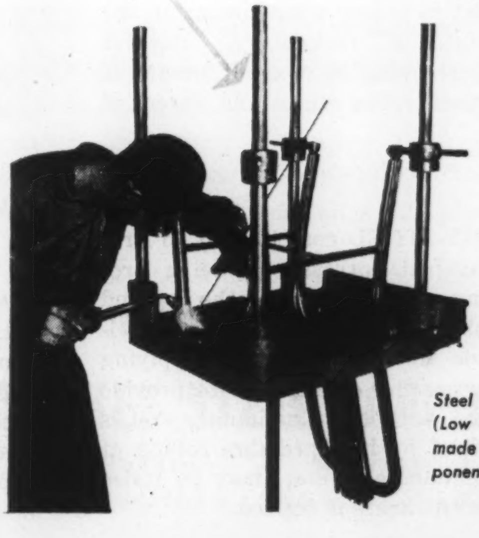
40 to 60%



Steel dresser. 36 welds are made on 20- and 22-gage cold rolled steel. Total time, including assembly, is less than 6 minutes.

The Simmons Company adds: "Under actual testing, we have a much stronger unit today than if we were using steel welding, due to the fact that the lower bronze-welding temperatures do not weaken the joint areas."

If you do either production or repair welding, write for Publication B-13. It covers *all* ANACONDA Welding Rods, their applications and procedures for their use. The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 49157



Steel chair. 56 ANACONDA 997 (Low Fuming) Bronze welds are made on each chair, with components aligned in welding fixture.

You can depend on ANACONDA

BRONZE WELDING RODS

TOPICS

X-RAY EXPOSURES of selected planes within an object are now possible by using a spiral laminagraph developed by the Naval Ordnance Laboratory at White Oak, Md. When instrument is in operation, film and object are in continuous, synchronous motion with respect to the tube.

MOTOR GRADER, light enough to travel by air, is capable of doing any job standard models can perform. Being tested for the Navy Bureau of Yards and Docks, the grader is driven through all six wheels by an 80-hp diesel and utilizes lightwegiht alloys in place of steel, effecting a saving of three tons. Boxes are provided for loading ballast.

DUCTILE CAST IRON, also known as nodular cast iron, has excellent engineering properties, particularly high tensile strength, elastic modulus, yield strength, toughness and ductility. Under patents recently granted to International Nickel Co., more than forty companies are now licensed to produce this new iron. Essential feature of the invention is the introduction of a critical amount of magnesium into the molten iron to produce a graphite structure in the form of spheroids or compacted particles, eliminating a substantial amount of the usual weakening flake graphite.

AIRFLOW ten times the velocity of sound has been achieved in a new wind tunnel at the California Institute of Technology. Highest speed previously recorded in a small tunnel of this type has been seven times the speed of sound.

ALUMINUM-ON-STEEL combination to protect the steel against corrosion is being produced by applying aluminum foil to the top and bottom of the steel sheet. The process, developed by Reynolds Metal Co., involves applying electrolytically a coating of fine iron to provide a permanent bond with the aluminum. Foil is bonded to the sheet by high-pressure rolling at 850 F. The aluminum-clad steel may be rolled further to reduce thickness if desired.

CRANKLESS ENGINE, being tested at Stanford University, may be developed to turn a turbine for driving an auto or truck. Characterized by extreme mechanical simplicity, the engine is lightweight, almost free from vibration and is inexpensive to build, operate and maintain. Suitable for use either as an air compressor or as an all-purpose prime mover, the engine theoretically has higher thermal efficiency than the modern diesel. The engine under test is a German Junkers single cylinder, 40 hp opposed-piston diesel operating on a two-stroke cycle with four steps of air compression.

VISUAL COMMUNICATIONS for aircraft are under development to overcome the limitations of voice communication. Advantages of printed messages would include improved accuracy, a permanent record, allowance of an interval between reception and reading, and ability to transmit maps and diagrams.

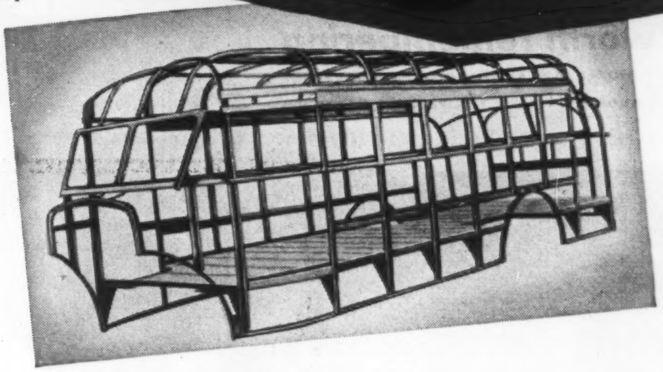
ADEQUATE PROTECTION of trademarks throughout foreign countries requires revision of the present world-wide system, according to the International Chamber of Commerce. Proposed revisions include: Prior registration in country of origin shall not be a condition for obtaining registration in other countries. Trademarks and translations thereof may be registered in one single act. Right of priority should be reserved for twelve months from date of filing in home country. Licensed use of trademark will be under control of registered owner.

WORLD'S MOST POWERFUL radio station will be built by the Navy at Jim Creek, Wash. Developing more than 1,000,000 watts the station will provide all-weather Naval communications in the area.

ATOMIC POWER PLANTS cannot be judged with respect to their economic possibilities until about $2 million has been expended for building a number of successive experimental plants, according to C. G. Suits, vice president and director of research for General Electric Co. If a profitable atomic industry does develop he believes it will be decades away.

FRAMED and COVERED with safety

Pictures courtesy of Oneida Products Corp.



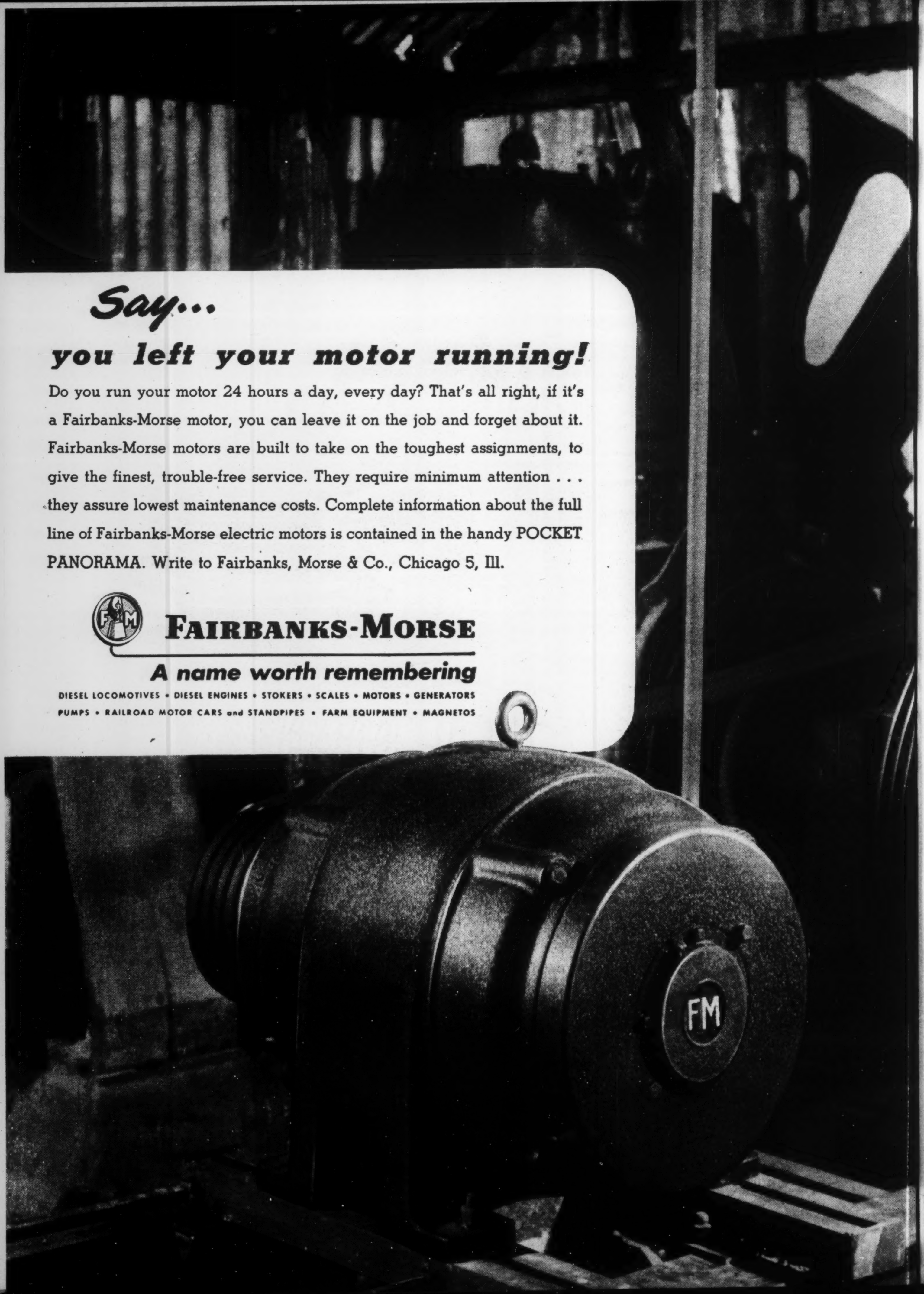
The greater strength and toughness of N-A-X HIGH-TENSILE steel permits weight savings of up to 25% in section—and still affords maximum protection against injuries from traffic accidents.

Its superior fatigue-resistance and excellent weldability prolongs this safety-factor . . . reduces maintenance costs over more miles and under all conditions.

If you manufacture a product requiring high strength, toughness and good weldability, it will pay you to investigate N-A-X HIGH-TENSILE.

MAKE A TON OF SHEET STEEL GO FARTHER
Specify—
N·A·X
HIGH-TENSILE STEEL

GREAT LAKES STEEL CORPORATION
N-A-X Alloy Division • Detroit 18, Michigan
UNIT OF NATIONAL STEEL CORPORATION



Say...

you left your motor running!

Do you run your motor 24 hours a day, every day? That's all right, if it's a Fairbanks-Morse motor, you can leave it on the job and forget about it. Fairbanks-Morse motors are built to take on the toughest assignments, to give the finest, trouble-free service. They require minimum attention . . . they assure lowest maintenance costs. Complete information about the full line of Fairbanks-Morse electric motors is contained in the handy POCKET PANORAMA. Write to Fairbanks, Morse & Co., Chicago 5, Ill.

FAIRBANKS-MORSE

A name worth remembering

DIESEL LOCOMOTIVES • DIESEL ENGINES • STOKERS • SCALES • MOTORS • GENERATORS
PUMPS • RAILROAD MOTOR CARS and STANDPIPES • FARM EQUIPMENT • MAGNETOS

DECEMBER, 1949

MACHINE DESIGN
A PENTON PUBLICATION

Standards Are Everybody's Business

ENGINEERING standards are a unique institution. Although, like regulations, laws and ordinances, they are established for the common good, they require neither enforcement officers nor legal penalties to make them effective. Instead they derive their force from their direct and self-evident value to each user. It follows that failure to establish much-needed standards can have painful consequences, as was amply demonstrated in the recent war. For example, the confusion due to lack of interchangeability between American and British threaded fasteners accelerated the development of the recently adopted unified screw thread standard.

Other much-needed standards are under development, and it is gratifying to observe, as noted on Page 155 of this issue, that one of the most sorely needed—hydraulic packings standards—has reached the stage of approval by the Joint Industry Conference. As with others, this standard reflects much voluntary effort by engineers representing both producers and users. So far as is humanly possible they have tried to evolve a practical and acceptable standard.

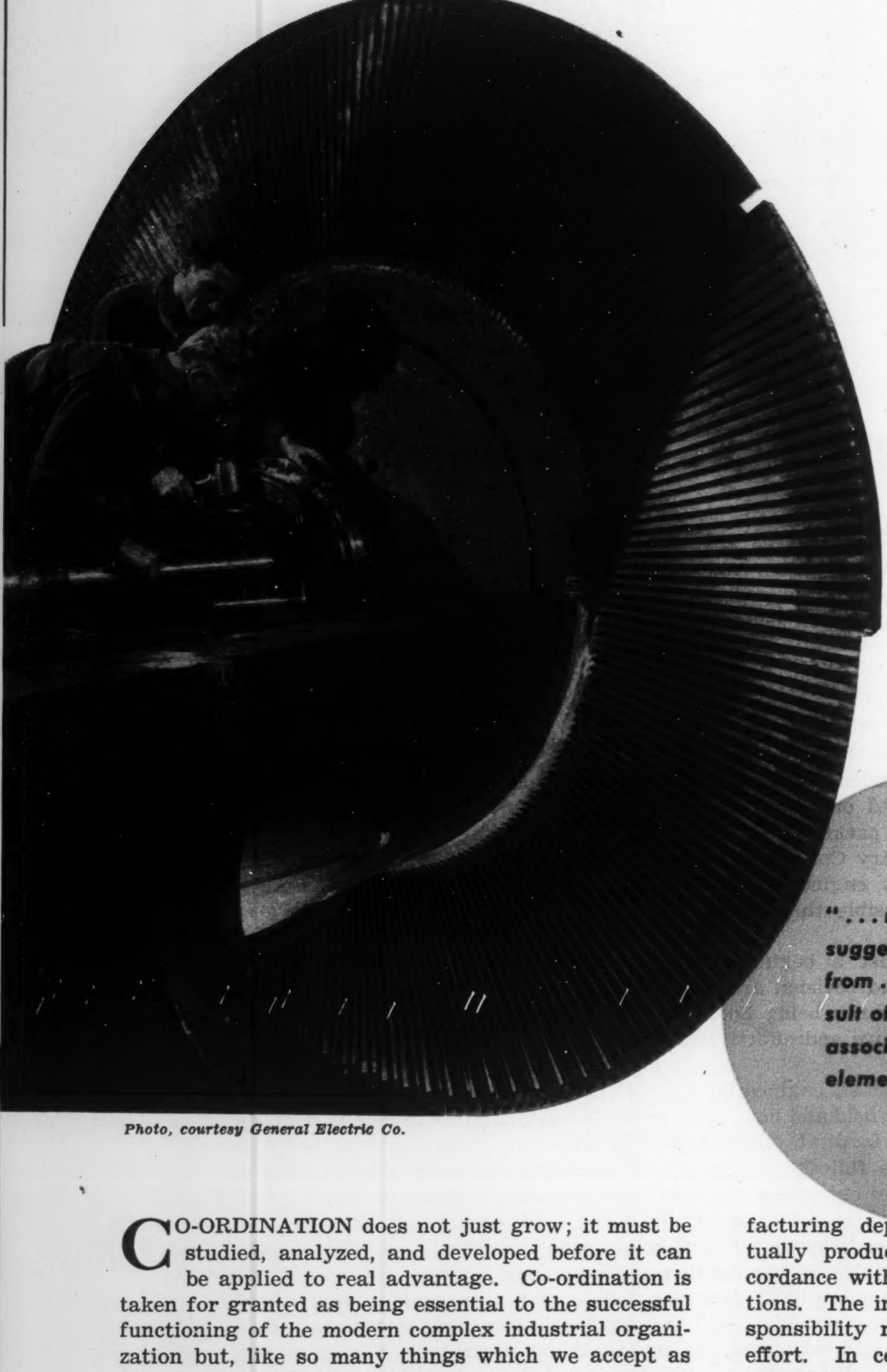
But this is just a beginning. Standardization is a continuous process. Frequent review and revision are essential to insure that a standard is neither hampering progress nor being ignored through obsolescence. To keep an engineering standard alive and effective requires the active co-operation of machine designers.

First and foremost, engineering executives must keep abreast of standards developments in the field and how adoption of these standards can help to simplify design, cut costs, facilitate procurement, reduce inventories, etc. They also should see that the fullest possible use of standards is made, thus promoting their acceptance and enhancing their value as well as providing the background of experience necessary to insure their being kept up to date. Finally they should voice their criticisms and suggestions where they will be heard by the committees responsible for maintaining the standards.

The various standardizing agencies such as industry groups, government departments, technical societies, and the American Standards Association need the active support and advice of engineers who use standards. Designers can therefore render valuable service to their profession by urging the establishment of standards where they see a need, by actively participating in standardization committee work, and through constructive criticism of standards in existence or under development.

Colin Carmichael

EDITOR



Photo, courtesy General Electric Co.

Engineering

A plan for effecting successful departmental co-ordination

By Harold A. Bolz
Professor of Industrial Engineering
Head
Department of General Engineering
Purdue University

> "...many invaluable suggestions have come from ... the shop as a result of intimate and expert association with the prime elements ..."

CO-ORDINATION does not just grow; it must be studied, analyzed, and developed before it can be applied to real advantage. Co-ordination is taken for granted as being essential to the successful functioning of the modern complex industrial organization but, like so many things which we accept as everyday necessities, it seldom receives the consideration which its importance justifies; neither is it given the conscientious application which is required to produce its full benefits.

Considering that the life blood of any industry is its products, it would seem obvious that co-ordination is most important between the engineering department and the shop. The engineering department carries the responsibility of determining designs, specifications and controls for the products and production methods with the object of securing the best ultimate relationship between profits, employee welfare, and customer satisfaction. The shop or manufacturing department has the responsiblity of actually producing the products economically in accordance with the engineering designs and specifications. The interdependence of these two areas of responsibility necessitates very close co-ordination of effort. In certain organizations some of these responsibilities may be shared by departments other than those designated as engineering and manufacturing, such as planning and control, but for the purposes of this discussion the broadest definitions of the terms "engineering" and "shop" will be assumed.

Before proceeding with an analysis of means which may be employed to effect wholesome co-ordination and co-operation between engineering and shop departments, it might be well to recognize specific reasons underlying the importance of such a relationship. Co-ordination between engineers and the shop is necessary in order to ensure: (1) Best possible product designs and production methods, (2) effective appli-

and Shop Relationships

cation of new materials, new methods and improved techniques, and (3) highest possible morale and the many mutual benefits thereof.

To realize these objectives, engineers must know how their designs and methods will suit the existing production facilities and personnel. They must understand the characteristics and limitations of the various production processes available. Their drawings, specifications and instructions must be prepared carefully and according to company standards so as to be perfectly clear and definite and readily understood by the shop and others using them. They must have ready access to the shop's suggestions for improvements and changes before production is started as well as after it has been put into operation. Progress grows from change but since all changes do not produce progress a very intimate working relationship between engineering and manufacturing is necessary to discover the most advantageous changes, to evaluate suggested changes and to apply them toward the optimum mutual benefit of management, employees and customers.

In order to prescribe means of promoting more effective relationships between the engineering department and the shop or manufacturing department, it is well first to analyze these two groups from the standpoint of the types of personnel of which they are composed, their respective working environments, the nature of their individual responsibilities, and the character of their jobs.

Engineers and Shop Men Compared

The first step on the road toward co-operation should be labeled *Understanding*. If each party were to understand and appreciate the other's way of thinking, his personal and group motivations, his job responsibilities and his environment, co-operation and co-ordination would be a natural result. As it is, however, engineering and shop personnel are likely to differ somewhat in a number of respects and consequently each often fails to consider certain vital factors involved in their relationships. These differences greatly influence the actions of these two groups as well as of the individuals in them.

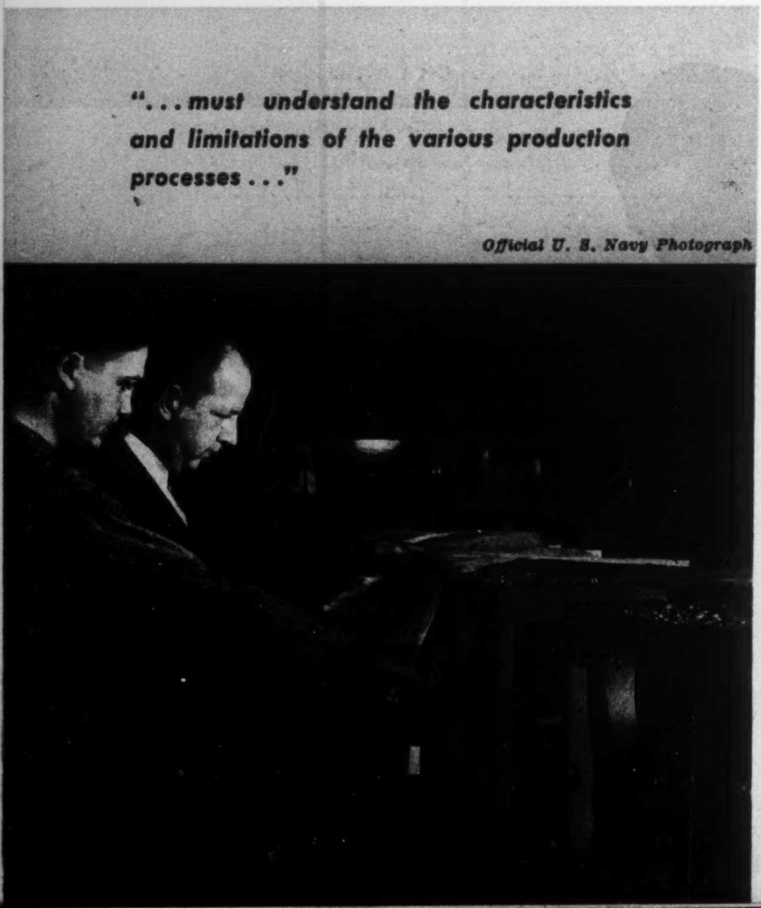
A comparison of engineering and production work, particularly in mass-production industries, yields a significant clew as to the basic differences between the personnel engaged in these two areas of endeavor. Engineering is by its very nature creative while shop work, especially in large-volume production, must needs be repetitive, closely organized, and standardized. As a consequence engineers are expected to be original, inventive, ready to initiate, quick to abandon

> **"...any organization, however great and complex...depends for its success upon basic man-to-man relationships..."**

Photo, courtesy Lockheed Aircraft Corp.

one idea in preference to a better one, and always alert to the potentialities of suggestions, criticisms and "wild ideas". Production workers, on the other hand, become tuned to the monotony of standardization, and accustomed to the sameness of the parts and methods with which they work. They too are alert to changes but changes to them may mean not new potentialities but possible trouble; changes to them may signify not opportunities for a better system but breakdown of the system with which they are intimately involved. The engineer's progress in his company usually depends upon his record of technological developments whereas shop men work under constant concern, whether it be justified or not, over the possibility of being displaced from their jobs by such technological changes. Engineers, therefore, learn to welcome change, production workers to resist it—both with good and sufficient but dissimilar reasons.

If the engineer is supposed to be a creator and an instigator of change, he naturally develops many viewpoints and traits which differ from those of the shop man who is charged with the responsibility of maintaining precision and sameness. The engineer becomes versatile, flexible and insatiably curious while his co-worker in the plant tends toward highly limited and often boring specialization. The engineer produces more effective results when he is charged with the responsibility of using his own initiative and originality while the operator in production often performs his work best when relieved of all such responsibility. This comparison between engineers and shop men is well illustrated by the definition often quoted that "wages are paid for doing what one is told to do, salaries for doing what needs to be done without being told". It is well to recognize here, however, that the boredom of repetitive work often nurtures remarkable degrees of manual and mental skills and affords the mind opportunities for profound thought and cogitation. Hence many invaluable suggestions have come from operators in the shop as a result of their intimate and expert association with the prime elements of their work. Young engineers, in particular, need to keep this in mind.[1] Both groups are definitely essential to any manufacturing organization and their individual characteristics should be recognized and fairly evaluated. Neither group is superior to the other in importance to the company for both have their purposes and value.



"... must understand the characteristics and limitations of the various production processes ..."

Official U. S. Navy Photograph

Actually all engineers are not as creative or progressive as they should be and neither are all machine operators as reluctant to accept changes as has been implied in this analysis. Foremen and other supervisory shop staff members generally are aware of the values and benefits of wholesome change but many, notwithstanding, are continually tempted to "leave well enough alone" in the face of the average worker's reaction to change. Since it is the foreman or supervisor with whom the engineer ordinarily deals, this difference in viewpoint is less serious than if he were to work directly with the machine operators themselves. Nevertheless, worker attitude has proved to be a potent factor in all industrial relations and must be understood and considered in all engineering-shop contacts.

Importance of Understanding

Tolerance, sympathy and understanding of the other fellow's aspect of the problem at hand furnish the key to more harmonious and effective co-ordination in engineering-shop relations as in any other field of human contact. Insofar as understanding is concerned in the engineer's point of view, he will do well to keep in mind that factory workers as a group, as revealed by an Elmo Roper poll, find less satisfaction and outlet for self expression in their jobs than do the professional and executive groups and consequently deserve a more tolerant and patient approach than they are often accorded.

How can the shop man be educated to look more favorably upon change? The answer is two-fold: (1) Show him how past changes have helped him as an individual worker and as a part of the organization and (2) give him a part in making future changes. All major changes in method, design, etc., should be followed up by a study and a simple report to emphasize all advantages brought about by the change. Disadvantages might be evaluated as a basis for developing further improvements. Advantages may be classed as those which improve working conditions and those which improve customer satisfaction and production economy. The former benefit the workers directly, the latter indirectly by improving the company's competitive position and hence the worker's employment security. Whether this information is conveyed by means of written reports or through meetings of the personnel concerned depends upon the individual organization.

Bulletins and written reports are at best only poor substitutes for personal meetings. Small group meet-

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[1] References are tabulated at end of article.

HAROLD A. BOLZ has more or less made a hobby of the study of personnel problems and professional engineering relationships. His down-to-earth findings and conclusions have been published in numerous prominent engineering, management and personnel journals. As head of the General Engineering department at Purdue his supervision covers industrial engineering and management, manufacturing processes and shops, and engineering drawing and descriptive geometry. His experience in industry and close collaboration with top industrialists in placement of graduates has helped to bring into sharp focus many of the obscure but highly important factors which make for optimum management-engineering-shop relationships. Formerly associate professor of mechanical engineering, Prof. Bolz has also made numerous contributions to the technical literature on machine design. He is a registered professional engineer and a member of ASME, AAAS, AAUP, and ASEE.

ings where men stimulate each other's thinking by their own comments are fine morale builders when properly conducted and can release a wealth of latent ideas. Whenever possible, the machine operators and plant personnel concerned should be invited to these meetings for it is their interest which is solicited. Such meetings are difficult to schedule and are time consuming; nevertheless they may be made to pay off handsomely in terms of enhanced employee morale and of productive ideas produced. Shop men who understand the benefits brought about by past changes and who have a part in initiating and perfecting new changes will gradually accept changes as a normal factor in the improvement of their own lot.

A Guide for Co-ordination: The problem of securing co-operation and a harmonious working relationship between the engineering department and the shop has certain elements which are common to human-relations problems in all areas of activity. Inasmuch as human beings are, in many respects, much the same across all strata of our society, many personal considerations involved in their relationship are common to all groups which are obliged to work together. These personal or human factors can be defined rather readily. In regard to the area of human activity covered by this article there are certain technical factors which probably are peculiar to this area. These technical matters or techniques likewise can be defined and brought out into the light for study and consideration to give what we might call a guide to the development of successful co-operation between the engineers and production staff in a manufacturing organization.

Human Relations: Any organization, however great and complex it may be, depends for its success upon basic man-to-man relationships. If this assumption is correct, it is clear that the same elements of tact, fairness, courtesy, sincerity, respect, congeniality, dependability and awareness of the other person's point of view which govern all personal relations must be observed in the negotiations which are carried on between the engineering department and the shop.

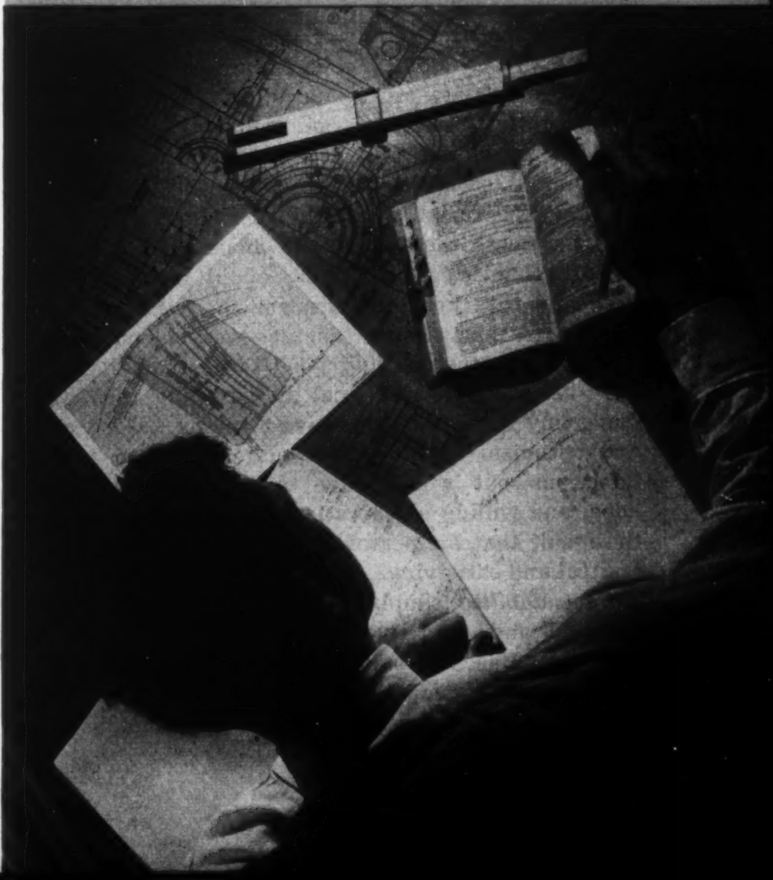
Tact requires delicate consideration and sympathetic perception of the other person's feelings. "What do you think about this idea?" promotes a receptive mood in the person being addressed, whereas "We have decided to do it this way" invites critical reaction and resistance.

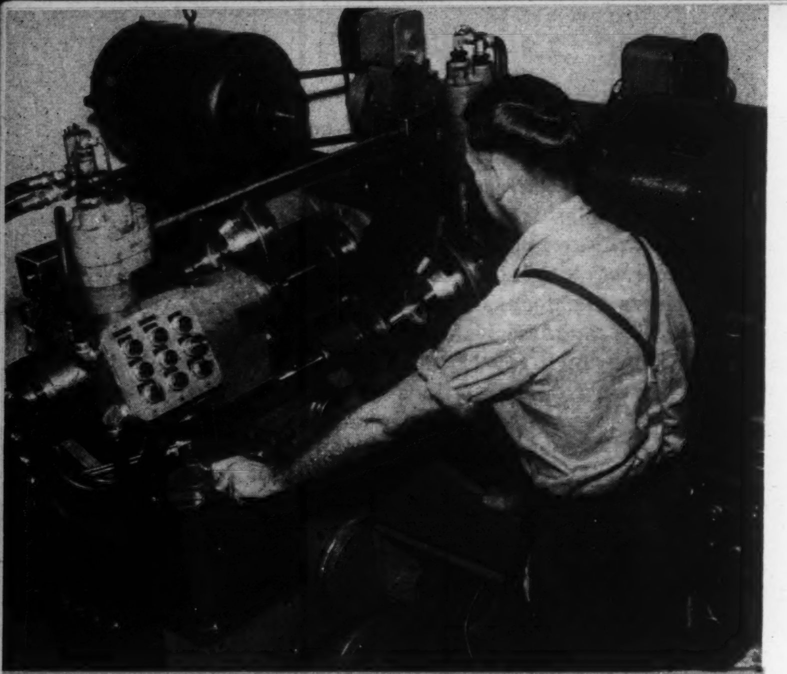
Fairness means giving credit where credit is due and requires honest, unbiased and conscientious square dealing in all matters. The engineer who appropriates ideas contributed by someone in the shop and then presents these ideas as his own without properly acknowledging the source is committing the worst violation of fairness because by implication he presents another's ideas as his own. The wages of unfairness are suspicion, distrust, and resentment which are the greatest of all deterrents to co-ordination.

Courtesy, sincerity and *respect* necessarily go together for courtesy without sincerity becomes hollow flattery, courtesy without respect might imply con-

"... drawings, specifications and instructions must be prepared carefully ... so as to be perfectly clear and readily understood ..."

Photo, courtesy Falk Corp.





Photo, courtesy Gisholt Machine Co.

". . . it might be well for engineers to bear in mind the fact that they depend rather heavily upon shop workers for data on machine performance, tool behavior, methods . . ."

descension, and respect without sincerity is meaningless. And it is probably true that "Please", "Thank you", "Excuse me" etc., can be used to excess in some shop groups. Again, young engineers sometimes associate the rough language and relatively dirty environment of certain shop areas with rough and uncouth manners and mistakenly assume the latter to be appropriate when dealing with shop men. This is a grave error in judgment since all persons respond favorably to courteous treatment discreetly and sincerely offered and shop men are no exception.

Since a ready smile, a cheerful air and an optimistic outlook contribute so much to the development of friendly and productive relationships, *congeniality* may be considered as a key consideration in human relations. Joe Smith, the Gloomy Gus of the engineering department, wondered why he could never get anywhere with the boys in the shop. As a matter of fact his habitual complaining about company practices and his chronic pessimism about business and world conditions seemed to infect everyone with whom he dealt, smothering any good ideas that they may have been able to offer and discouraging them from doing any further constructive thinking. Good cheer and optimism on his part would have been just as infectious but would have elicited encouragement, hope, and willing co-operation in place of gloom with the result that his personal contacts would have been fruitful and satisfying.

Dependability, implying *promptness, punctuality, accuracy* and *integrity,* is one of the strongest bonds that can be used in building a sound human relations structure. Dependable Dave does what he says he will do and is supposed to do—as it should be done and when it should be done. Dependability means not only doing *what* you said you would do *when* and *how* you said you would do it; it means doing whatever you are expected to do by reason of your job responsibility and doing it *as* and *when* it is supposed to be done. The engineer who checked a certain fixture which he saw was causing trouble and had it corrected before the operator raised a fuss won the respect of that operator immediately. The result was that together they were able to work out an improvement that yielded great savings and brought recognition to both of them.

Although the factor of *awareness of the other's point of view* has been listed as a separate consideration, it is obvious that all factors previously mentioned depend upon this important one. In fact this one, which really epitomizes the Golden Rule, is *The Law* as far as all human relations are concerned. It embodies the individual approach which has become so important in our complex and increasingly impersonalized industrial structures. It demands that one know the person with whom he is dealing—know him personally, understand him, understand some of the motivations which drive him or the fears which inhibit him. One's immediate reaction to this, however, would be that no engineer has time to make friends with every individual with whom he has to deal in the shop, at least not to the extent that has been implied in this discussion. This may be true, of course, but since it is usually attitude rather than acts alone which govern the nature of dealings between individuals, it is essential that these personal and human considerations not only be understood but be considered seriously and be put into practice whenever possible. The engineer who learned that the experimental tool room foreman wrote poetry as a hobby always had an avenue of approach to get that occasional rush job done in the tool room. That foreman always seemed to find time to help the fellow who admired poets, even though they might be amateurs.

Values in Shop Man's Ideas

In pondering over these matters it might be well for engineers to bear in mind the fact that they depend rather heavily upon shop workers for their source of data on machine performance, tool behavior, methods, etc. The operator lives with his machine, so to speak, learns to understand its peculiarities and advantages and in some instances becomes a virtual library of experience and a storehouse of ideas. Many of these ideas are latent and will never come to life without proper stimulation. Others are active and alive but will never be expressed without proper encouragement. The engineer, consequently, is in a position to supplement his own background of knowledge and experience if he develops the techniques of encouraging workers to express their ideas. This means that he must not only understand the shop man's attitudes and his problems but also his "shop dialect". No worker will contribute information willingly and wholeheartedly unless he feels that he is a part of the organization that is going to use this material for his benefit as well as for the benefit of the company. While the engineer must solve the problem of developing the kind of man-to-man relationship that will bring this co-operation into effect, the management of his organization must recognize the fact that there is a limit to what can be accomplished through personal dealings between individuals alone. Management should lend its support through an organized procedure of recognizing and rewarding worthwhile suggestions and contributions of constructive and creative ideas and should give the engineer a prominent part in judging such suggestions.

Importance of Specifications

COMMUNICATIONS: One of the critical links in the chain of personnel and industrial relations is that of communication. An individual may be motivated by the highest ideals of personal conduct toward his associates and management may likewise operate under the highest type of personnel policy; however, if explanations, orders, requests, and instructions are not made clearly, definitely, and in keeping with the principles of tact, courtesy, fairness, sincerity and dependability, misunderstanding may develop and ill will, latent or active, may be engendered where nothing but good will was intended.

Specifications: One of the major impediments to engineers in gaining the confidence of shop men arises from ambiguous information specified on drawings. Such notes as "cut to suit", "weld", "drill to fit part so-and-so", "finish for slide fit", etc., in lieu of specifying tolerances and finishes and making other definite instructions on drawings undermines the shop man's faith in the knowledge, ability and integrity of the engineer who is responsible for the drawings. When the engineer assumes the right of specifying designs he must accept the responsibility for making decisions as to fits, finishes and other details vital to the satisfactory performance of the part. To pass incomplete or ambiguous information to the shop shifts the burden of these decisions to the shop. This is either a form of "buck passing" or a display of carelessness, irresponsibility or incompetence—in any case detrimental to sound co-ordination and wholesome personnel relations.

APPLICABLE TECHNIQUES: Although these general principles governing human relations as applied to the associations between engineering and shop personnel are fairly simple it might be well to consider some of the specific techniques which are applicable in this particular relationship. Attitudes, again, are of paramount importance, for it is often possible to get good results using rather poor human relations techniques solely by reason of the ingenuous nature of the person so doing. In a complex industrial organization, however, too much is at stake to depend upon anything but the soundest of techniques, examples of which may be enumerated as follows.

Direct Work Through Designated Organization Channels: This might be labeled as the prime technique of all. Cutting under a foreman weakens his position, confuses his men and establishes serious barriers to subsequent negotiations. Following prescribed organization lines and "building up" the supervisor to his men strengthens the confidence of employees in their departmental management and in their superiors and in turn yields stronger support to those dealing with that department. The purpose of this discussion is not to specify any particular type of organization. The structure itself is not as important as is the fact that some specific organizational structure must be defined and that that structure then must be respected and followed. If it is a sound working structure it will avoid overlapping responsibility and authority and will impose *no* responsibility *without* granting corresponding authority.

Systematize Plant Visits by Engineers: Regardless of the specific nature of the organizational pattern it is necessary for certain engineers in every company to make frequent visits to the plant. This practice is a potential source of trouble and should be controlled and systematized to give the best results. Not only is it possible for plant visitations to consume an excessive amount of engineering time but such

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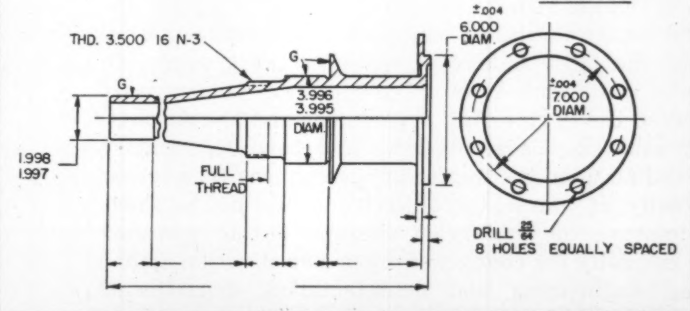
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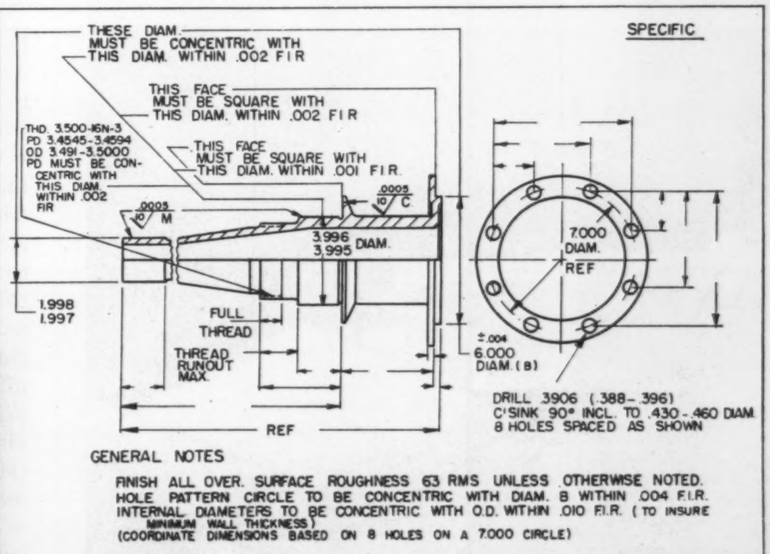
> **"... ambiguous information specified on drawings ... undermines the shop man's faith in the knowledge, ability and integrity of the engineer ..."**

SPECIFIC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GENERAL NOTES

FINISH ALL OVER. SURFACE ROUGHNESS 63 RMS UNLESS OTHERWISE NOTED.
HOLE PATTERN CIRCLE TO BE CONCENTRIC WITH DIAM. B WITHIN .004 F.I.R.
INTERNAL DIAMETERS TO BE CONCENTRIC WITH O.D. WITHIN .010 F.I.R. (TO INSURE MINIMUM WALL THICKNESS)
(COORDINATE DIMENSIONS BASED ON 8 HOLES ON A 7.000 CIRCLE)

visits also contribute toward the distraction of the manufacturing staff with resultant loss of production. Furthermore, these visits may inspire a certain feeling of resentment on the part of the shop staff who ordinarily are less free to roam and seldom enjoy the privilege of visiting the engineering department facilities. Some organizations handle this problem by the technique of designating specific liaison engineers to deal with the shop staff and require others to secure special passes or to register for trips to the plant. This plan places plant visits on an orderly basis, minimizes time killing, and promotes the respect which naturally develops for any efficient and well orgaized group. Furthermore, it is well to conduct as much of the co-operative business between departments through regularly scheduled meetings as is possible and to reduce impromptu visits to a minimum. The use of the telephone and of written communications also serves to expedite negotiations between departments.

At this point, however, it must be recognized that individual personal contact is a wholesome thing for plant morale and certainly should never be discouraged. The foregoing suggestions are offered only as means of controlling and systematizing interdepartmental visits and are definitely not meant to imply that such visits could or should be prohibited nor that engineers should be cloistered or isolated from shop influences. That organization which discourages the personal touch—the friendly approach and the mutual understanding which results from the informality of face-to-face conversation—sacrifices that great source of strength which comes through the joint efforts of men who are willing to work together to make things go when the prospects of success are weakest. In fact it might be very desirable in many organizations to establish a regular program of personal shop contacts carefully planned, properly timed and diplomatically developed by certain key engineers selected for their natural skill and tact in handling such matters. Since there is no satisfactory substitute for wholesome personal contact in any phase of industrial relations such a planned program might serve as a means of establishing a sound pattern of personal contacts which might ultimately be adopted by all personnel involved.

". . . paper properly designed, co-ordinated and handled can contribute greatly to efficient operation . . ."

Photo, courtesy Reliance Electric & Engineering Co.

Secure Proper Approval Before Making Changes: There probably is no phase of activity that causes more severe strain on engineering-shop relations than does the improper initiating and handling of engineering changes. Changes in design, materials, tolerances, scheduling, routing, processing, etc., ordered by the engineering department certainly must have prior approval of those persons responsible for maintaining production under the changed condition. Even when a change is sound and wise we know that "the shop" will react against it unless they have had a part in establishing it in the first place. A systematic procedure under the co-ordination of a liaison engineer, including proper shop representation for planning and processing of changes, will contribute much toward improving the nature of the changes themselves and of insuring their wholehearted reception by the shop.[2, 3]

Product Development Committees

The incidental effect which such a system will have in developing more wholesome feelings between the departments concerned may, in many situations, prove to be the most significant effect of the system. Of course, the same type of co-operation is necessary between the engineering department and the purchasing, sales, methods, planning and cost departments depending upon the nature of the changes themselves. Actually, of course, the objective should not be solely to improve the quality of changes but to minimize the necessity for changes. Proper co-ordination among sales, engineering and manufacturing departments through a product development committee can accomplish this objective.[4] Rank and file employees working with engineers, salesmen and production supervisors on such committees have been found to contribute immeasurably toward cost-cutting developments.[5]

Understand Union-Management Agreements: Engineers, especially the younger ones, have been known to cause considerable trouble for themselves in their dealings with the shop staff through their lack of familiarity with, and in many cases downright ignorance of, the contract provisions governing the relationship between the union workers and the management. Inasmuch as the work of engineers often brings them into direct contact with the machine operators themselves as well as their work it is essential that both parties, in order to understand fully each other's point of view, certainly must be familiar with the regulations under which each is employed. The chances are that most union members will usually understand the engineers' specific position in this respect but very often the converse is not true.

Effect of Labor Agreements

Inasmuch as labor agreements not only influence personal behavior of employees but also affect working conditions, methods, materials, sequence of operations, etc., the engineer cannot do properly his work of designing, planning co-ordinating and controlling products and production without a thorough familiarity with pertinent provisions and restrictions. The wide variety of tasks assigned to engineers in most industrial organizations makes it difficult to determine the extent to which labor-relations training should be given to the engineering staff. For best results this should be part of every engineer's background and he should be kept up to date by management on all current developments in this respect. The importance of this point cannot be too strongly emphasized if it is accepted that the individual approach and the personal man-to-man contact previously discussed are important in the maintenance of sound and effective relationships between the engineering department and the shop or manufacturing staff.

Maintain Distinction Between Engineering and Shop Work: In general it is not advisable to require members of the engineering staff to perform ordinary shop operations which might be involved in the completion of a project carried out under their supervision. Shop operations require definite skills for satisfactory execution. Engineers, as a rule, do not possess these skills to an acceptable degree of competency. Granted, however, that some engineers may possess satisfactory manual skills, their time generally may be much more effectively applied to creative and analytical functions. To encourage or require engineers to do certain shop work as a regular part of the performance of their engineering duties lowers their prestige as professionally trained men and infringes upon some of the prerogatives of the shop staff.

Admittedly it is important that the engineer be capable of operating the machine which he has designed. Furthermore, it enhances the engineer's reputation in the plant to be able to demonstrate occasionally that he can handle production equipment, but his prestige suffers if he is expected to continue such operations as a regular part of his work. In many plants regulations definitely prohibit engineers from performing the tasks normally assigned to mechanics, machinists and operators. In plants where such regulations are not in effect it will nevertheless be found desirable to limit the performance by engineers of functions and services ordinarily ascribed to members of the manufacturing and production staff.

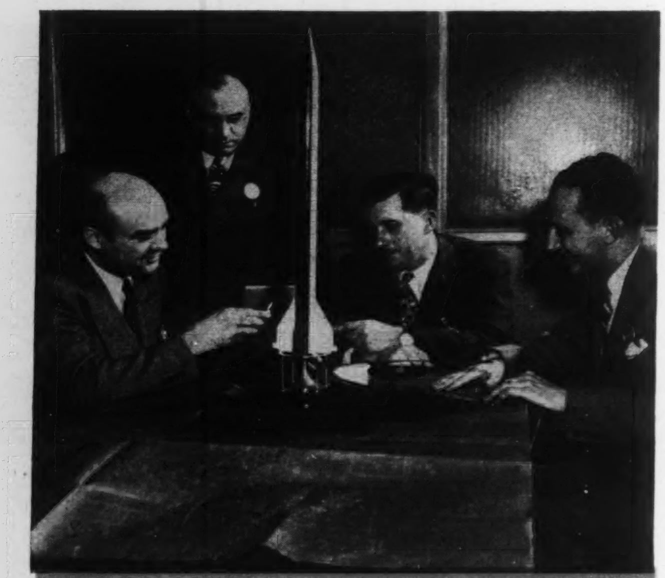
Photo, courtesy Lyons Metal Products Inc.

"... co-ordination among sales, engineering and manufacturing departments through a product development committee can accomplish this objective ..."

Shop workers like to feel that they possess definite and peculiar skills. Even though an enginer may possess a certain skill in a degree comparable to that of a production worker with whom he must associate there is a real question as to whether by demonstrating his skill he will gain more in respect than he might lose by having deprived the worker of his own feeling of superiority. As in all human relations this is a question which can be answered only in the light of all personal factors involved in the specific case at hand.[6]

Use "Paper" Effectively: The greatest mechanical aid for expediting relations between the engineering department and the plant or manufacturing department is paper. The term "paper" as generally used in this connection includes the various records, orders, requisitions, bills of materials, drawings, notices, requests, reports, inquiries, schedules, etc., which serve as means of communicating and recording the vast amount of detailed information required in the production of industrial products. Such pieces of paper properly designed, co-ordinated and handled can contribute greatly to the efficient operation of an industrial organization. On the other hand, however, records, figures, statistics and reports have a great fascination for certain types of minds and extreme vigilance and precaution must be exercised to keep the paper system itself efficient, to eliminate unnecessary steps, useless records and worthless reports from gradually developing like a parasitic growth sapping the strength and vitality of an otherwise normal and healthy system.

In order to establish a system of records and communications on an efficient basis and to maintain it on a sound basis, it is necessary that the primary



Photo, courtesy Glenn L. Martin Co.

"...engineering is by its very nature creative . . . engineers are expected to be original, inventive, ready to initiate, quick to abandon one idea in preference to a better one, and always alert to the potentialities of suggestions, criticisms and "wild ideas"..."

purposes of such a system be understood. These purposes may be outlined as follows:

1. To standardize and systematize communication and recording procedure
2. To standardize and define terminology, nomenclature, units and methods employed in the organization
3. To save time and effort in communication, planning, scheduling, analysis, accounting, etc.
4. To minimize errors in communicating and recording information
5. To provide lasting, convenient and accurate records for later reference
6. To expedite procurement and handling of materials
7. To minimize the amount of computing, estimating, designing, specifying, etc., required of workers whose jobs otherwise do not involve the exercise of judgment and skill in mathematical or analytical thinking.[7]

These objectives cannot be satisfied by a paper system that is not thoroughly planned and carefully designed. Every record, every report, requisition, order, etc., must be individually designed so that it will have exactly the information which it is intended to convey with no unnecessary information and no repetition. It should be designed so that it not only will carry the proper information but will be arranged so that these data may be recorded and transcribed with a minimum amount of effort and motion considering whether it is to be typed or filled out by hand.[8] A record should be designed to be conducive to accuracy not only in recording but also in reading and transcribing. It should have the necessary qualities of durability, ease of handling, etc. The sizes and proportions of the individual pieces of paper used in any system should be selected carefully, keeping in mind such factors as standardization and uniformity, convenience in handling and filing, adequate space to allow legible and accurate entries, and economy.

These rather mechanical considerations might seem somewhat insignificant to be brought into a discussion of this sort. However, it is certainly true that just as properly designed and handled records and communications may greatly increase the efficiency of an operating organization so can a poor system greatly reduce efficiency and, more important, become irritating, fatiguing and annoying to the user.

There Are No Human-Relations Slide Rules

In discussing with engineers a subject such as co-ordination there is a danger in overemphasizing specific methods and techniques to be applied like formulas to particular cases as they arise. It is well to bear in mind in all considerations of problems involving human relations that it is the individual who is usually the basis or the nucleus of the problem and that as an individual he must be dealt with in the light of his own peculiar characteristics. Sound company policies and clear-cut standard procedures concerning the development and maintenance of the type of co-ordination and co-operation outlined herein are important but it must be emphasized again that successful industrial relations in the last analysis depend upon successful relations between individuals concerned.

Policy and standard procedures should be designed so as to facilitate and encourage sound human relations performance by all personnel. Individual human beings cannot be handled by the slide-rule methods of engineers for no slide rule or formula can possibly include all of the variables encountered. Rules and regulations themselves often produce harmful reactions, especially when tactlessly imposed or when unreasonably numerous or petty.[9] Through proper analysis of and approach to the human as well as the technical factors mentioned in this discussion co-ordination between engineering and shop can become one of the most potent of all forces working for industrial progress.

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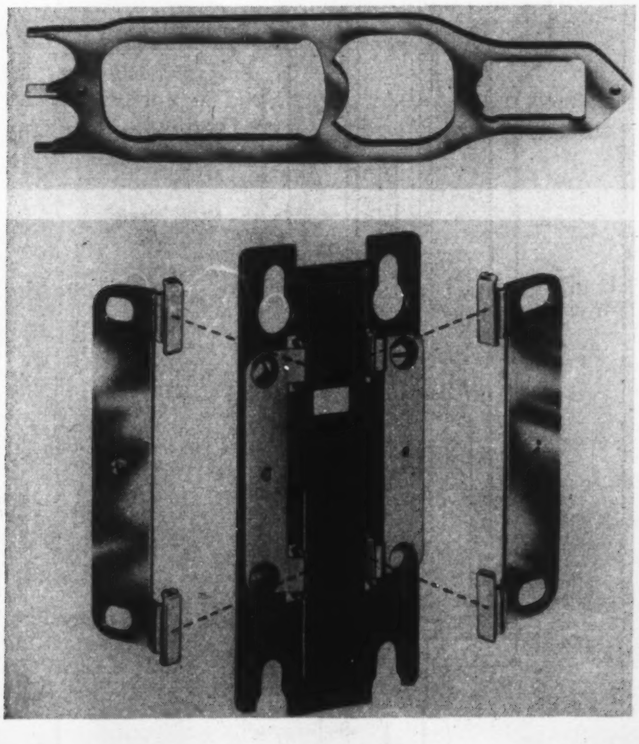
SCANNING the Field For Ideas

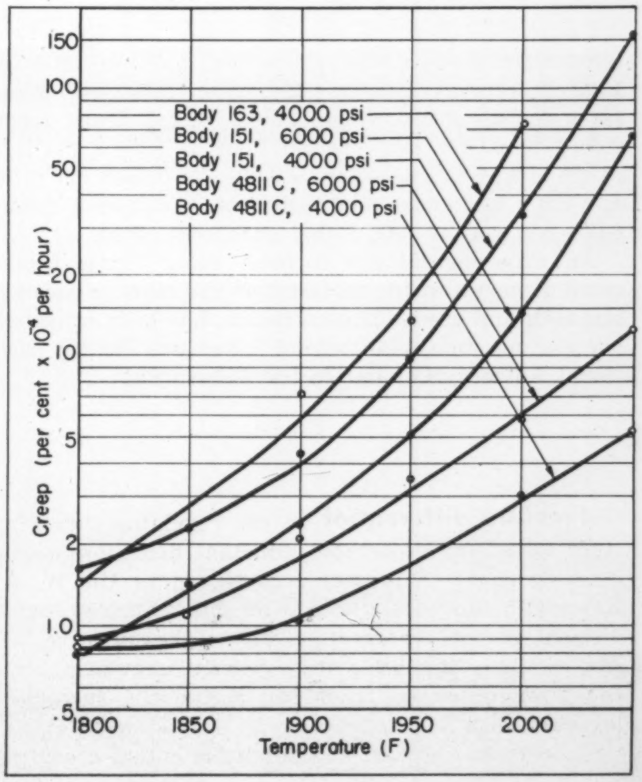
Sapphire inserts on the film shuttle and film side guides, below, for motion picture projectors eliminate difficulties caused by uneven rates of wear on the intricate mechanism and increase the normal wear life of the unit by approximately 400 per cent. In addition, the inserts increase normal film life. On the cam-actuated shuttle the insert acts as the actual contact finger which engages the sprocket holes in the film to place a new frame before the projection aperture 24 times each second. Due to the high abrasive nature of film, shuttles with hardened steel fingers will wear sufficiently to interfere with smooth operation, causing film damage in about 250 hours of operation. Sapphire fingers, however, show no appreciable wear after 1200 hours, equivalent to more than 100 million cycles.

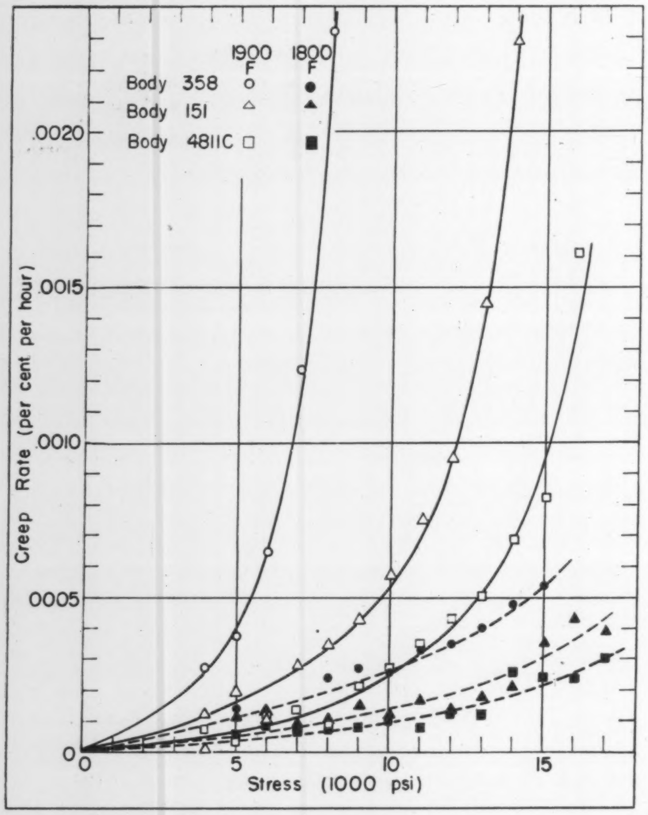
Side guides of chromium plated steel, subjected to continual wear as they bear on the edge of the film under spring pressure, normally wear out in approximately 500 hours in providing the necessary braking action to stop the film briefly 24 times a second. Sapphire guides continue to function efficiently, showing no wear, after 2000 hours. These special inserts were developed by the DeVry Corp., manufacturer of projectors, and the Industrial Products division of the Elgin National Watch Co., fabricators of sapphire.



Ceramic materials developed at the National Bureau of Standards have marked superiority, in both strength and creep characteristics at 1800 F and above, over the best available high-temperature metal alloys. Of the six oxide materials tested at the bureau, the creep characteristics of three are shown in the two sets of curves, one for constant temperature and the other for constant stress.

In the tests, each combination of stress and temperature was maintained for about 160 hours. Conditions were then changed by an increment of either stress or temperautre, until failure, for a total of 109 tests. Strengths in tension up to 18,000 psi at 1800 F and 15,000 psi at 1900 F were observed. Above





1900 F, however, the strengths drop off rapidly to an average of about 5000 psi at 2000 to 2200 F.

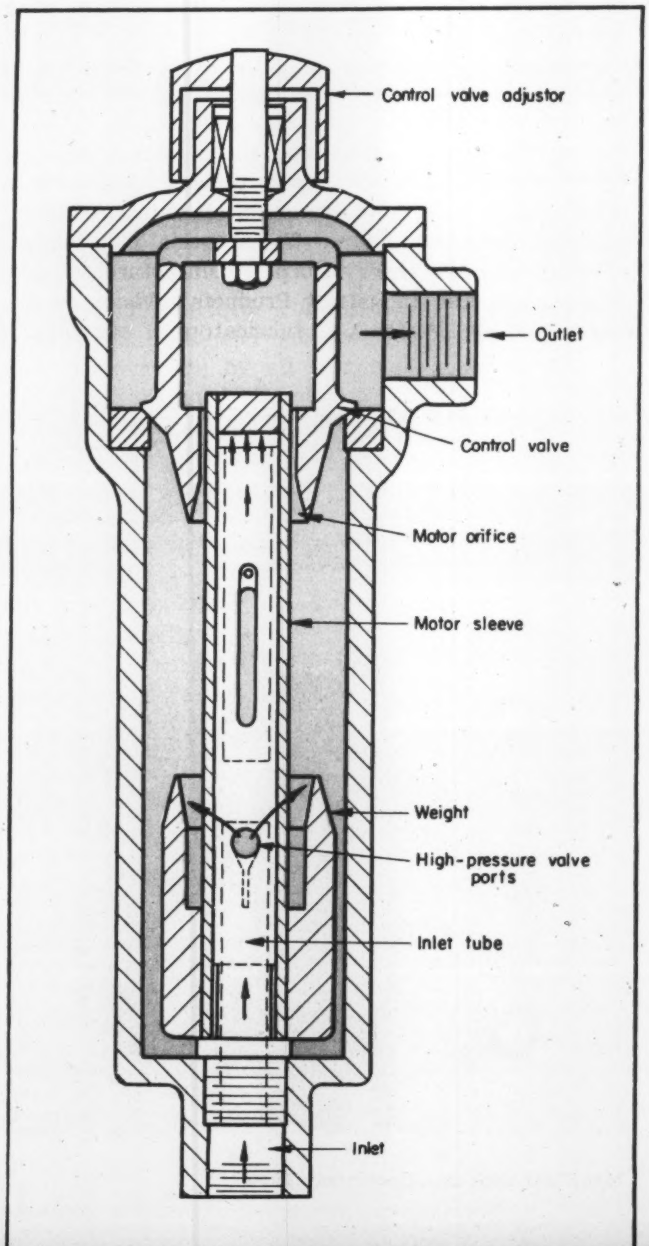
Resistance to creep also decreases rapidly when temperatures are raised above the range of 1800 to 1900 F (curves above). Maximum observed creep rates for all the porcelain bodies tested range from 0.0001 to 0.0002 per cent per hour at 1700 F for the range of stresses used; from 0.0002 to 0.0008 per cent at 1800 F and a stress of 16,000 psi, and from 0.003 to 0.004 per cent at 1900 F and 10,000 psi stress.

An experimental gas turbine, using blades fabricated from the oxide material of the most promising strength and creep characteristics, has been operated successfully in the Cleveland laboratory of the National Advisory Committee for Aeronautics.

Pressure differential in the regulator shown at right maintains adjustable, constant fluid flow which is independent of pressure. Designed by the W. A. Kates Co., the regulator has its differential pressure element in the center of a valve disk and is so arranged that the differential element regulates both the pressure across itself and across the surrounding valve disk.

Fluid from the inlet at the bottom enters a central vertical tube and flows through high-pressure valve ports into the low-pressure part of the casing. From there it flows through the motor orifice. Being restricted, this flow sets up a pressure differential between the low-pressure and the outlet portions of the casing. This differential tends to lift the motor sleeve and attached weight. Because the inlet tube is stationary, the high-pressure valve tends to close as the motor sleeve lifts. When the upward force of the pressure differential equals the pull of gravity on the motor sleeve mass, the motor sleeve will come to rest. For any particular combination of orifice and fluid, the pressure differential is determined by the volumetric flow.

If fluid is shunted through the control valve to the outlet, the motor will still maintain a constant pressure differential across its orifice and a constant flow through it by operation of the high-pressure valve. Flow through the control valve will also be constant, and the sum of the two component flows will be constant regardless of variations in inlet pressure, outlet pressure or both. A control valve knob at top of unit provides adjustment of total flow through the regulator by varying the opening of the control valve.



Determining BALANCING Accuracy

By Werner I. Senger
Manager
Balancing Machine Division
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By a series of tests, the balancing accuracy of both static and dynamic balancers can be readily determined to arrive at the practical specifications which can be used for machine parts to be balanced in production

USE of balancing machines to measure and locate static and dynamic unbalance in rotating bodies is assuming greater importance as design for higher speeds progresses. Balancing machines are available in a variety of types, sizes and accuracies. Generally, it is easy to select the proper type and size machine for a given job or jobs. However, it is generally difficult for a purchaser of a balancing machine to determine the accuracy of balance required for his work and it is still more difficult for the buyer to assure himself that the balancing machine selected will measure unbalance to the required order of accuracy.

The balancing of rotating bodies is undertaken as a precision operation, *Fig.* 1. Therefore measurements must be made with a precision device. It is just as reasonable to provide an operator with an insensitive balancing machine and then expect perfect results as it is to provide the operator of a cylindrical grinding machine with a wooden yard stick and expect him to measure diameter to accuracies of 0.0001 or even 0.001-inch. It is therefore desirable that some simple means be provided whereby the required accuracy and also quality of work produced on a balancing machine may be readily determined.

MACHINES AND PRINCIPLES: There are two general types of balancing machines: (1) Static and (2) dynamic. A static balancing machine, *Fig.* 2, measures the displacement of the center of gravity of a body from the rotational axis of the body. Dynamic balanc-

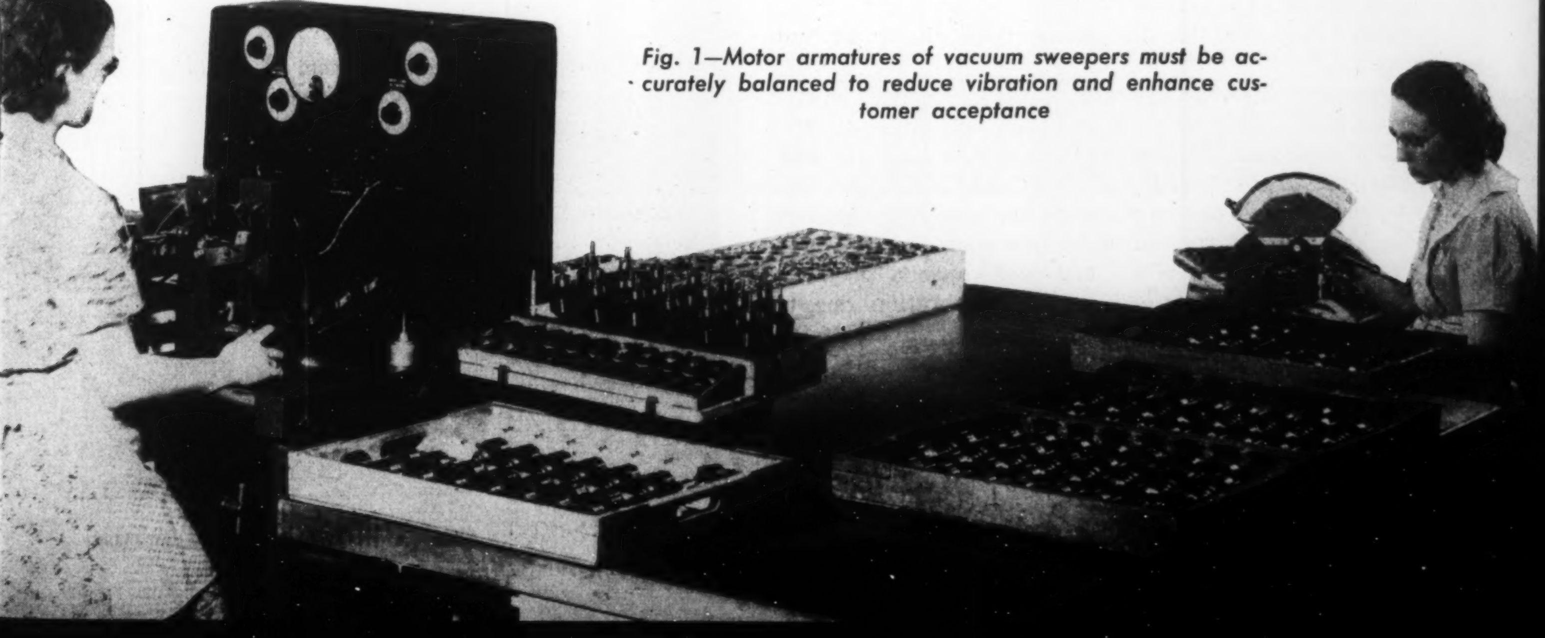


Fig. 1—Motor armatures of vacuum sweepers must be accurately balanced to reduce vibration and enhance customer acceptance

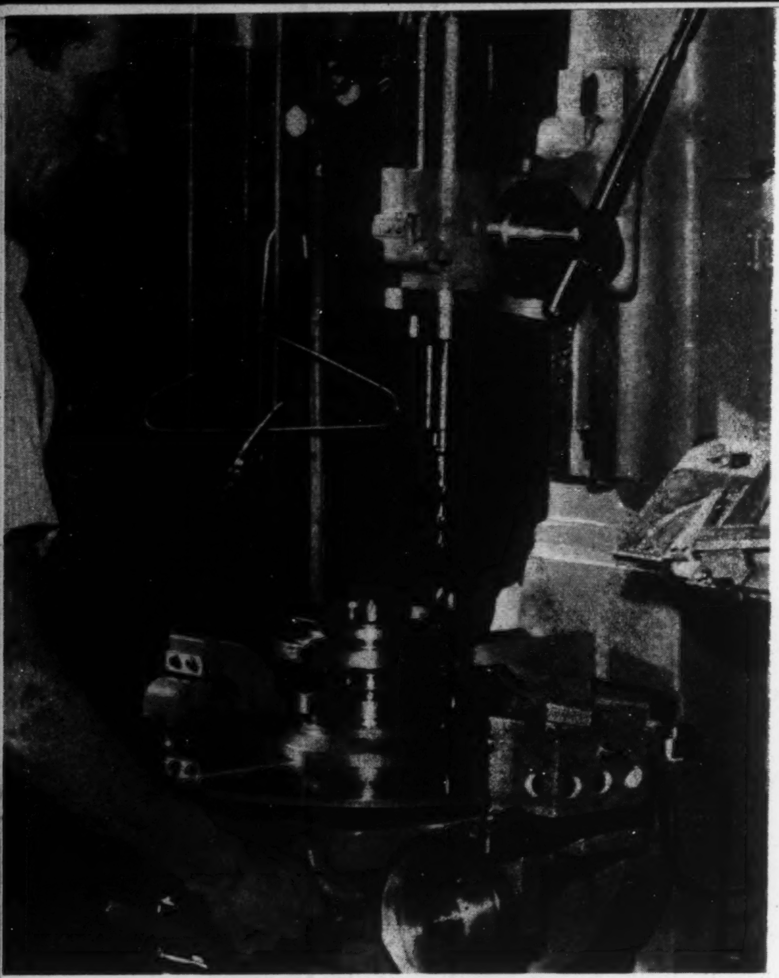


Fig. 2—Static balancers are generally used for measuring and correcting unbalance in disc-like parts such as the belt pulley and vibration damper assembly shown

ing machines measure the combined effect, at the bearings, of displacement of the center of gravity and displacement of the principal inertia axis from the rotational axis as determined by the bearing. These measurements are more readily understood by reference to *Fig.* 3, which is intended to reppresent any body which is to be balanced. The line *ZZ* represents the rotational axis as determined by the bearings supporting the body and *cg'* represents the actual location of the center of gravity of the body before balancing. Line *Z'Z'* is parallel to *ZZ* through the center of gravity *cg'*. A static balancing machine measures the effect of the mass of the body displaced the distance *e* from the rotational axis.

In *Fig.* 3, Z″Z″ represents that principal inertia axis of the body which most nearly coincides with the rotational axis. This axis is inclined at an angle with respect to the rotational axis and, of course, the principal axis passes through the center of gravity *cg'*. When not restrained by bearings, the body will rotate about axis *Z″Z″* and will cause a displacement *p* of the left-end bearing. Vibration due to unbalance is produced by the continual efforts of the body to rotate about axis *Z″Z″* even though it may be restrained and forced to rotate about axis *ZZ*. It is the purpose of a dynamic balancing machine to measure the displacement of *Z″Z″* with respect to *ZZ*.

Balancing machines, then, measure displacement. The formula for determining the displacement is approximately:

$$p = \frac{wr}{W} + \frac{wrhJ}{g(I_x - I_z)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where w is a weight producing unbalance in the body, r is the distance from the rotational axis to the weight w, W is the weight of the body, h is the distance between a transverse plane containing w and a transverse plane containing the center of gravity, j is the distance from the center of the bearing to the center of gravity of the body as indicated in *Fig.* 3. and I_x and I_z are, respectively, the moments of inertia of the body about the *XX* and *ZZ* axes. This formula is developed in Part I of "Specifying Dynamic Balance" published in the November, 1944, issue of MACHINE DESIGN.

This displacement formula may be rewritten as:

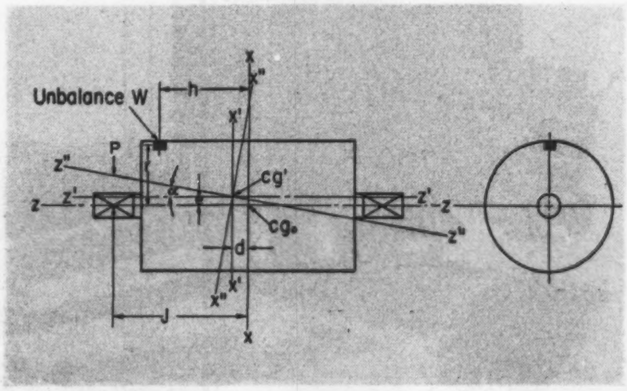
$$wr = \frac{pWg\ (I_x - I_z)}{g\ (I_x - I_z) + WhJ} = p\ \frac{Wg\ (I_x - I_z)}{g\ (I_x - I_z) + WhJ} \quad (2)$$

If w is in ounces and r is in inches, unbalance can be read in ounce-inches and the unbalance so indicated is proportional to the bearing displacement p. So, by introducing unbalance effects in ounce-inch values, we can find means for checking the accuracy of a balancing machine. Before proceeding further, it should be noted from the formula that an unbalance which will produce a desired minimum bearing displacement p is a function of the weight W of the body, the moments of inertia of the body I_x and I_z, the distance h, and the distance J.

Equipment: The equipment required to determine the accuracy of a balancing machine is readily available. The radius at which unbalancing test weights are applied may be measured by use of a scale or may be determined from a drawing of the parts to be balanced. Simple test weights are also readily available. The weight of some easily available material is given in TABLE 1. It is necessary to provide special test weights for unusual jobs and where exact information is required as to the accuracy of balance. The exact weight of special test weights may be accurately determined on a chemist scales or on any other accurate scales.

In addition to the above equipment, it is desirable

Fig. 3—Diagram showing displacement of rotational axis resulting from dynamic unbalance



to have available some chewing gum, shellac or other material whereby the test weight may be attached to the workpiece while checking the balancing machine for accuracy.

REQUIREMENTS OF A STATIC BALANCER: It is essential that certain precautions be taken to insure that the balancing machine does not receive criticism for errors which are not assessable against the machine. Some errors may be due to the manufacturing tolerances permitted on the workpiece while others may be due to eccentricities in the adapter which locates the workpiece.

Support Surfaces Important

The surface or surfaces on the balancing machine which locate the workpiece must run true with respect to the bearings from which these surfaces receive their support in the balancing machine. When an arbor is used for supporting a workpiece for balancing on knife edges, *Fig.* 4, the locating surfaces are the diameter and face on the arbor by which location of the work is determined. The supporting surfaces are those diameters which actually rest on the knife edges. In the vertical type of static balancing machine, the locating surfaces are the diameter and face from which the work is located, *Fig.* 5. The supporting surfaces are the spindle bearing surfaces of the machine.

Runout of the locating surfaces with respect to the supporting surfaces can always be determined by means of a dial indicator using common inspection processes. Permissible runout can be determined from the following formula: Runout (total dial indicator reading) = desired balancing accuracy in ounce-inches ÷ weight of the workpiece in ounces. If the runout (total indicator reading) exceeds the value determined from this formula, the unbalance in the work due to the runout will exceed one-half the established balancing tolerance. It is desirable that the runout be less than this value so that the balancing machine operator may easily balance to the desired tolerance.

Fig. 4—Typical arrangement for horizontal static balancing

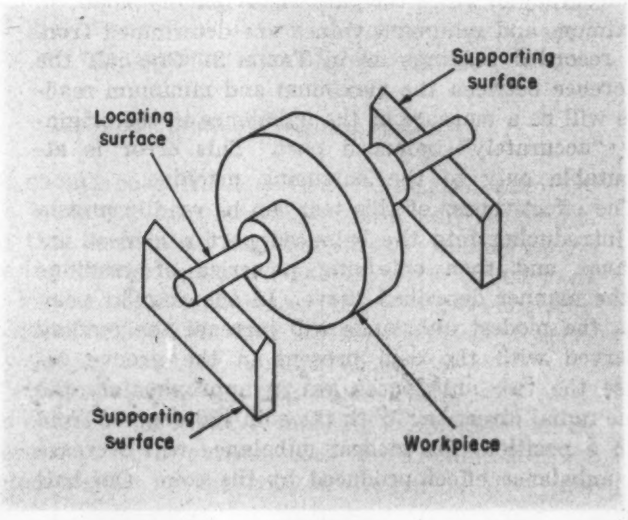
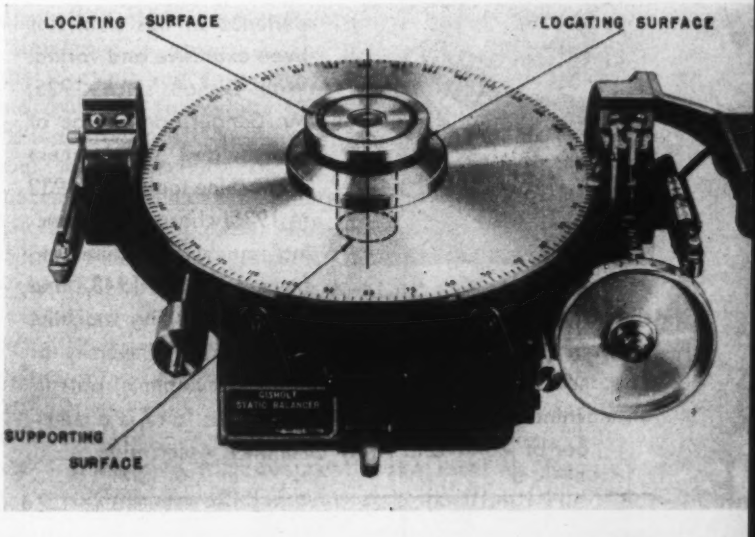


Table1—Test Weights for Balancing

Type of Weight	Weight (Ounces)	Lack of Uniformity (Per cent Error)	
Coins			
Copper "One cent" piece	0.109	2	
"Five cent" piece	0.175	2	
A "Dime"	0.087	1⅓	
A "Quarter dollar"	0.219	1	
A "Half dollar"	0.435	1	
Wax Balls (Flexo Wax, Light, Type "C" mfg. by Glycol Products Co. Inc.)			
⅛" diam. ball	0.00075	6	Note:
3/16" diam. ball	0.0015	7	Do not use
¼" diam. ball	0.0057	8	where exact
½" diam. ball	0.0468	9	answers are
1" diam. ball	0.3114	10	required
Modeling Clay			
⅛" diam. ball	0.001	6	Note:
3/16" diam. ball	0.003	7	Do not use
¼" diam. ball	0.008	8	where exact
½" diam. ball	0.056	9	answers are
1" diam. ball	0.400	10	required
Steel Rods			
0.125" diam, 0.125" long	0.007	1	
0.1875" diam, 0.1875" long	0.023	1	
0.250" diam, 0.250" long	0.055	1	
0.500" diam, 0.500" long	0.441	1	
0.375" diam, 0.375" long	0.185	1	

A second precaution is to use a workpiece which fits the locating surfaces perfectly. If there is play between the workpiece and the locating surfaces on the balancing machine, unbalance effects will be introduced which are not caused by inaccuracies in the balancing machine. Play between the workpiece and the locating surfaces of a static balancer can cause differences in unbalance measurements of a magnitude which can be determined by the following formula: Unbalance effect in ounce-inches = Weight of the workpiece in ounces × play between workpiece and locating surface in inches. Obviously, this play or freedom must be reduced to a value which can produce an unbalance effect considerably less than the balancing accuracy required of the machine. It is desirable that this error be less than one-fourth the accuracy desired of the machine. Having taken these pre-

Fig. 5—Machine designed for vertical static balancing



cautions, one is ready to fairly determine the accuracy of a static balancing machine. The part which snugly fits the locating surfaces of the balancing machine should be balanced to the utmost accuracy obtainable on the machine. This can be done by repeating the unbalance measuring and correcting operations until the unbalance indicating means on the machine show zero unbalance in the workpiece.

Checking for Repeatability: This test can be made by introducing an unbalance into the balanced workpiece by adding a known weight at a measured radius. The product of weight in ounces by the radius in inches should introduce an unbalance corresponding to approximately 100 per cent of the maximum unbalance readable on the balancing machine indicating device. This unbalance should be measured ten successive times without moving the work from its initial position with respect to the locating surfaces of the balancing machine and without changing the unbalance artificially introduced. Each such measurement should be taken carefully by following, in its entirety, the procedure normally used to measure the amount of unbalance. Any one of the ten readings so obtained should deviate from the average value by less than one-quarter of the guaranteed or desired accuracy tolerance if accumulations of errors are to be avoided.

Consecutive Tests for Repeatability

Similar tests for repeatability should be made with artificial unbalance effects approximately equal to 20, 40, 60 and 80 per cent of the maximum value readable on the machine. Any one reading should deviate from its corresponding average value by less than one-quarter of the guaranteed or desired accuracy tolerance if accumulations of errors are to be avoided.

WERNER I. SENGER is one of the outstanding authorities on balancing and balancing design. Having helped pioneer the development of balancing machines at Gisholt, his experience in this field has been extensive and varied. With Gisholt since 1925, Mr. Senger had charge of design and development of machine tools from 1932 to 1935, charge of balancing machine engineering from 1935 to 1943, and since then has been manager of the balancing machine division. He has a BSME degree from the University of Wisconsin and a MSME from Yale, has a number of patents on machine tools and balancing machines, and is a member of ASME and Army Ordnance Association.

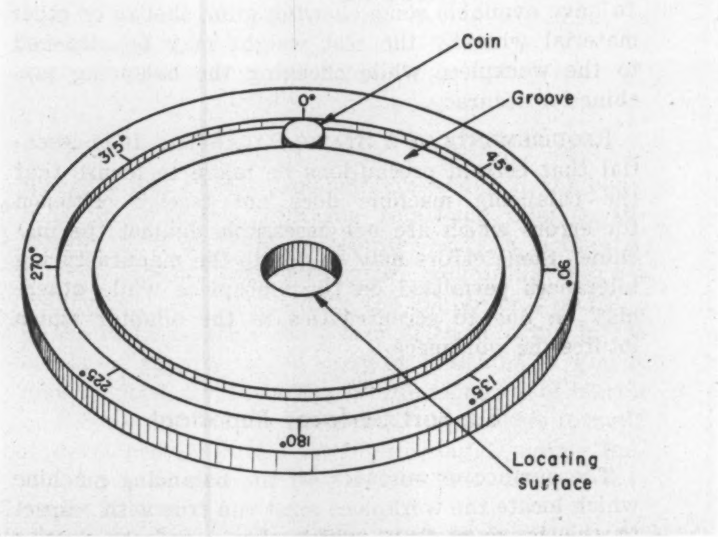


Fig. 6—Grooved workpiece used for making static unbalance tests

Check for Ability to Measure a Known Unbalance: A groove exactly concentric with its locating surface should be turned in the workpiece, *Fig.* 6. The locating surface of the workpiece must be a good fit on the balancing machine. The precise radius to the center of the groove should be recorded. The width of the groove should be exactly the same as the diameter of a coin or test piece of known weight. It should be here noted that it may be necessary to prepare a special weight to properly check some types of parts. Eight equally spaced radial lines are then marked off on the groove and stamped 0 through 360 degrees by increments of 45 degrees.

In making this test, the unbalance introduced should be at least 30 per cent of the maximum possible machine reading and at least 20 times the balancing tolerance as read on the machine. Measure, by use of the normal process for measuring unbalance on the machine, and record the amount of unbalance indicated with the test weight at zero-degree position. This test is repeated with the test weight moved to positions marked 45, 90, 135, 180, 225, 270, and 315 degrees. If due allowance is made for the repeatability of machine readings, the variation in readings of amount of unbalance obtained at the several angular locations will provide means for determining the accuracy to which the part was originally balanced. Maximum and minimum values are determined from the recorded readings as in TABLE 2. One-half the difference between the maximum and minimum readings will be a measure of the unbalance in the originally "accurately" balanced part. This error is attributable only to the balancing machine.

The effectiveness of this test can be readily proven by introducing into the balanced part a modest unbalance and then obtaining a series of readings in the manner described above. In one angular position, the modest unbalance will increase the reading observed with the coin present in the groove because the two unbalances are in approximately the same radial direction. With the coin 180 degrees from such a position, the modest unbalance will decrease the unbalance effect produced by the coin. One-half

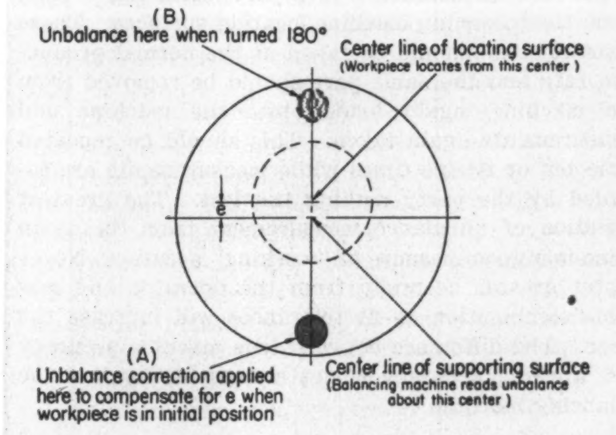

(B)
Unbalance here when turned 180°
Center line of locating surface
(Workpiece locates from this center)
e
(A)
Unbalance correction applied here to compensate for e when workpiece is in initial position
Center line of supporting surface
(Balancing machine reads unbalance about this center)

Fig. 7—Diagram showing determination of lack of concentricity of locating and supporting surfaces

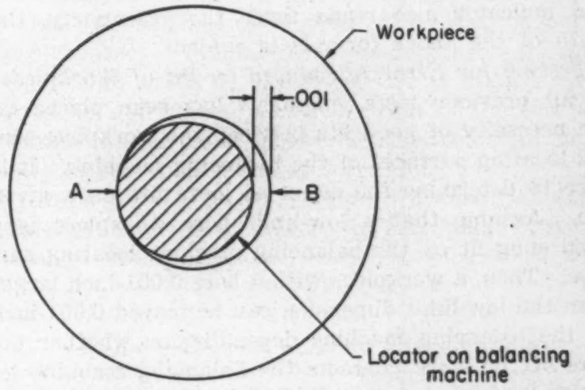


Fig. 8—Workpiece with clearance in bore introduces error which must be taken into consideration

the difference between the maximum and minimum readings will be the amount of the modest unbalance introduced.

This error inherently in the machine definitely establishes the accuracy to which the machine can be expected to read unbalance. This error should be less than one-fourth the desired balancing tolerance.

Checking Angular Accuracy of Machine: With the part modified as in *Fig.* 6 and balanced to maximum accuracy, introduce a known unbalance in the 0-degree direction. This unbalance should be at least 20 times the desired tolerance and more than 30 per cent of maximum machine reading. Measure and locate by the normal balancing procedure the angular position of the test weight. Apply at the indicated angular location a correction of the same type as was used for unbalancing the work piece. If the angular location is not 180 degrees from the angular position of the unbalance originally introduced, the angular error is the difference between the 180 degree position and the location indicated by the machine. The effect of this error in balancing machine units may be determined by measuring the unbalance remaining after application of the correction. Repetition of this test with the unbalance introduced at 45, 90, 135, 180, 215, 270, and 315-degree positions will give a complete picture as to the angular accuracy of the machine for all directions.

Importance of Angular Accuracy

It should be noted here that the angular accuracy of a balancing machine is important only to the extent that corrections of proper amount applied at the angular location indicated by the balancing machine can leave residual unbalance. The residual unbalance should not exceed one-half the desired machine accuracy in any test for angular accuracy.

Determining Machine Calibration: From the readings obtained in TABLE 2, machine calibration can be determined. It is obvious that the machine reading produced only by the coin or weight is 10.0, this being the average value of the recorded indications. This reading corresponds to an unbalance in ounce-inches represented by the product of the coin weight in ounces and the radius to the center of the groove into which coin was placed. By dividing the ounce-inches of coin unbalance by the machine reading, a factor is obtained which can be used as a multiplier to obtain unbalance in ounce-inches from machine readings. In determining machine calibration, it is always wise to use an unbalance effect which will produce a reading of at least 30 per cent of the maximum possible machine reading. With this multiplier available, errors observed in the preceding tests may be reduced to ounce-inch values.

Machine Provides Test for Concentricity

Test for Concentricity of Locating and Supporting Surfaces: A good balancing machine will in itself provide a means whereby the concentricity of locating and supporting surfaces may be determined. A workpiece which has a snug fit on the locating surface is measured for unbalance and corrected to the greatest possible accuracy. Rotate the workpiece 180 degrees with respect to the locating surface of the balancing machine and measure the unbalance. If an unbalance is observed, the lack of concentricity of the locating and supporting surfaces can be determined from the following: Unbalance in ounce-inches at 180-degree position = weight of workpiece in ounces × eccentricity (total indicator reading) of supporting and locating surfaces.

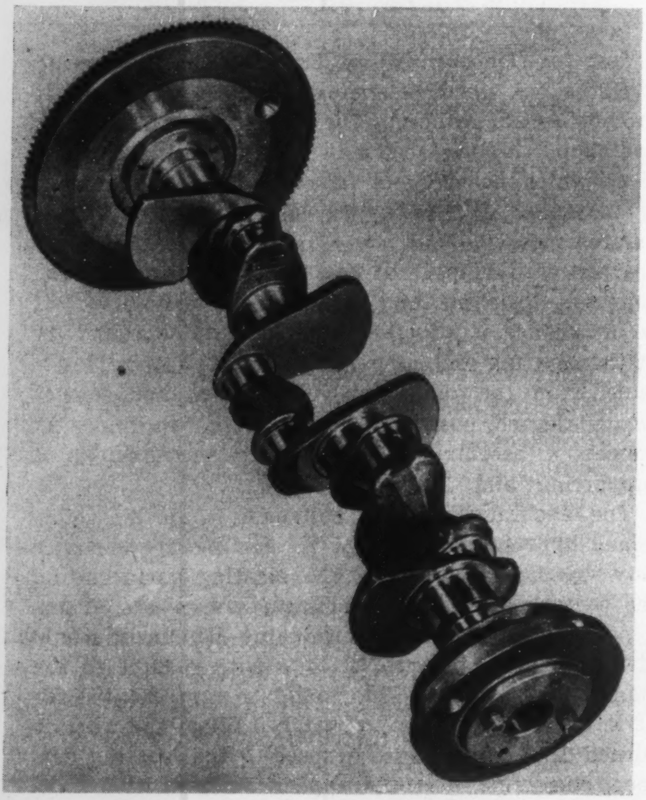
The accuracy of this statement may be determined by reference to *Fig.* 7. Assume the distance between the centerline of the locating surfaces and the centerline of the supporting surfaces is *e*. Then, a perfectly balanced part weighing *W* ounces would introduce an unbalance $W \times e$ with respect to the supporting surfaces. This would be compensated for at *A* by the addition of a weight. When the work is turned 180 degrees with respect to the locating surface, correction *A* would appear at *B* position. The balancing machine would then measure the effect of $W \times e$ plus correction A. As A is also equal to $W \times e$, the balancing machine will read 2 $(W \times e)$. As a dial indicator also reads twice the eccentricty, the truth of the above formula is evident.

Testing for Error Introduced by Fit of Workpiece: In all previous tests, emphasis has been placed on the necessity of good fits between the workpiece and the locating surfaces of the balancing machine. It is wise to determine the effect of loose fits on a given job. Assume that a low-limit bore workpiece is a good snug fit on the balancing machine locating surface. Then, a workpiece with a bore 0.001-inch larger than the low-limit dimension can be moved 0.001-inch on the balancing machine depending on whether the bore of the work contacts the balancing machine locating surface at *A* or at *B, Fig.* 8.

If the part weighs 1000 ounces (62.5 pounds) and is balanced with contact at point *A*, the same part will be 1000 ounces × 0.001-inch or 1.0 ounce-inch out of balance when contact is at point *B*. Balance errors of this nature are not assessable against the balancing machine. They can be reduced only by control of manufacturing tolerances on the workpiece.

Checking Working Accuracy of Static Balancer: In most of the preceding tests, emphasis has been given to obtaining accurate readings. Unfortunately, production is often materially decreased if the balancing machine operator takes time to obtain accurate readings. Furthermore, in production, it is not reasonable to expect an operator to exercise the necessary care. It is wise, therefore, to determine a "working" accuracy for a machine.

Fig. 9—This rotating assembly from an automotive engine is corrected for dynamic balance by drilling at both ends. Holes can be seen in vibration damper and flywheel



The balancing machine operator should measure and locate the unbalance in a part which has a snug fit on the balancing machine locating surfaces. These measurements should be taken at the normal production rate and the same part should be removed from the machine, again loaded into the machine and measurements again taken. This should be repeated some ten or twelve times while measurements are recorded by the party making the test. The greatest deviation of unbalance measurement from the mean value is a good measure of "working" accuracy. Never expect greater accuracy from the operator and machine combination as fit tolerances will increase the error. The difference between true machine accuracy and working accuracy is not chargeable against the balancing machine.

Errors in Correction Devices

Accuracy of Correction: Balancing machines measure and locate the amount of unbalance correction required in a workpiece. Correction devices are often incorporated as integral parts of balancing machines. Failure of these devices to add or remove the indicated correction cannot be considered as an error in the balancing machine. Of course, correction errors do show up as an unbalance in the finished product. For a discussion of these errors, see "Specifying Dynamic Balance" in the January, 1945 edition of MACHINE DESIGN.

REQUIREMENTS OF DYNAMIC BALANCING MACHINE: It is well known that corrections for balance must be made in two planes to dynamically balance a rotating body, *Fig.* 9. See Part I of "Specifying Dynamic Balance" in the November, 1944 issue of MACHINE DESIGN for proof of this statement. These correction planes must be perpendicular to the rotational axis and must be spaced some distance apart. Their location is generally determined from limitations imposed by the design of the workpiece. It is the function of a dynamic balancing machine to determine the amount and angular location of correction weight to be added or removed at established radii in each of these planes. From these requirements it is possible to develop a series of tests for accuracy of dynamic balancing machines (two plane corrections).

While balancing machines do measure displacement, the amount of correction weight to add or remove is a function of the physical characteristics, mass and mass distribution of the workpiece as well as the displacement (Equations 1 and 2). Therefore, all tests for accuracy of a dynamic balancing machine are best made with a workpiece for which a given balancing accuracy is desired. Then, by computation it is possible to determine from Equation 1 the axis displacement, at the workpiece bearings, due to a given unbalance effect.

Precautions in Testing: The dynamic balancing machine should be carefully set up in accordance with the manufacturers' recommended practice. All driving devices, supporting bearings or rollers should meet the balancing machine manufacturers' specifications so that errors measured are truly errors chargeable to the balancing machine.

Check for Ability to Separate Unbalance Effects into Corrections Required in Two Selected Planes: It has been previously stated that a dynamic balancer should measure and locate the amount of material to add or remove, in each of two selected transverse planes in the workpiece, to give balance. It is therefore important that the unbalance indication in one plane be unaffected by unbalance in the other plane. To check the ability of a balancing machine to separate these unbalance effects, a workpiece should be carefully corrected for balance to the maximum accuracy obtainable on the machine. In one of the transverse planes of correction a weight should be added which will produce an unbalance effect at least 20 times the desired tolerance for balance in that plane or an unbalance which will give at least 30 per cent of maximum machine reading. Set the machine to read unbalance in the plane which does not contain the unbalance. The dynamic balancing machine should indicate zero unbalance for this condition. Practically, the unbalance indication should not exceed 2 per cent of the unbalance introduced.

This test should be repeated with unbalance introduced only in the plane not originally used. With the machine set to read unbalance in the plane *not* containing the unbalance, the machine should indicate not more than 2 per cent of the unbalance effect introduced.

For these tests, unbalance effects may be introduced by adding known weights from TABLE 1 at a known radius in the plane of correction. It may be necessary or desirable to provide special weights for some jobs.

Check for Errors Introduced by External Disturbances: With a workpiece mounted in the machine and with the machine arranged to indicate vibrations produced by unbalance in one plane of the workpiece, observe the unbalance indication with the driving motor stopped. A balancing machine is a vibration indicating device and some machines may give unbalance indications under this test. Such indications are due to vibrations coming into the machine from external sources and are a measure of errors which are present in every measurement taken on the machine. Obviously, the machine should show zero reading under these test conditions. This test should be repeated with the machine arranged to read unbalance in the other transverse plane.

Effect of Motor on Balance

Unbalance indications on the machine for each correction plane should also be noted when the driving motor is operated without being connected to the work spindle. Obviously, the machine indications under these test conditions will be due to vibration produced by the driving motor.

Check for Repeatability: Introduce an unbalance into one correction plane of the accurately balanced workpiece by adding a known weight at a measured radius. The unbalance should be of such magnitude as will cause the unbalance indicating device to give a full scale reading. Ten successive unbalance measurements should be then carefully taken and recorded. The procedure normally used to determine the amount of unbalance should be carefully followed. Any one of these measurements should deviate from the mean value by less than one-fourth of the desired balancing accuracy. Similar tests for repetition should be made with artificial unbalance effects approximately equal to 20, 40, 60 and 80 per cent of the full scale value. These tests should be repeated with unbalance in the other plane of correction.

Check for Ability to Measure a Known Unbalance: This test is made separately for each plane of correction by adding a known weight to a balanced workpiece and measuring unbalance effects in the manner outlined for static machines. One-half the difference between the maximum and minimum readings in each plane of correction is a measure of the unbalance in the originally accurately balanced part. This machine error in each correction plane should be less than one-fourth the desired balancing tolerance in that plane.

Table 2—Record of Unbalance Readings

Angle at which unbalance is placed on the workpiece	Amount of unbalance indicated by the balancing machine
0	10.1
45	10.0
90	9.9
135	9.8 (Min)
180	9.9
225	10.0
270	10.1
315	10.2 (Max)

Check for Angular Accuracy of Machine: This test should be made for each correction plane by introducing a known unbalance and following the test procedure described for static balancing machines. In each correction plane, the machine errors should not exceed one-half of the accuracy to which it is desired to correct for balance.

Determination of Machine Calibration: With the machine indications obtained in the above, the calibration can be determined for each plane of correction by the procedure described for static balancing.

Test for Working Accuracy: Using a similar type part, which is unbalanced, repeatedly determine and record the amount and location of unbalance in each plane of correction at the normal production rate. The maximum deviation of the indications from mean value is the working accuracy of the machine.

Test for Unbalance Introduced by Driving Means: After a workpiece has been accurately balanced, arrange to drive the workpiece when indexed 180 degrees with respect to its original angular location relative to the balancing machine driving mechanism. The amount of unbalance now observed in each plane of correction is twice the unbalance actually introduced by the driving means. This error may be due in part to attachment of the driving means to surfaces on the workpiece which are not concentric with the rotational axis. Errors remaining when the driver-locating surface is concentric are due to the driving means.

Highlights in MACHINE

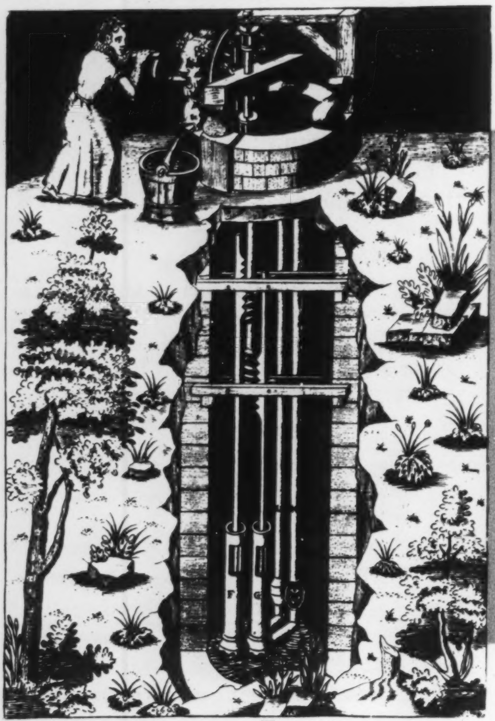


Fig. 4

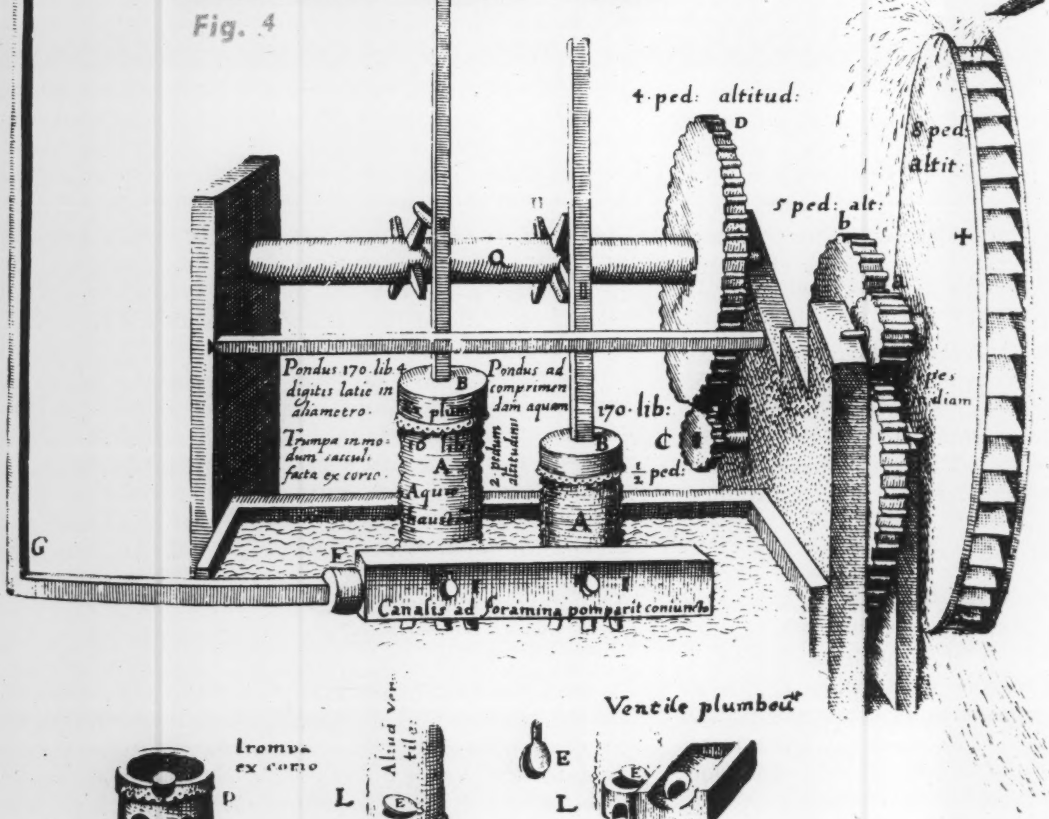

4·ped: altitud:
D
8 ped: altit:
5 ped: alt:
b
Pondus 170 lib 4 digitis latie in diametro
Trumpa in modum sacculi facta ex corio
B
plumb
170 lib
A
Aqua hauriendi
Pondus ad comprimendam aquam
2 pedum altitudini
170·lib:
C
½ ped:
A
G
F
Canalis ad foramina pom parit coniuncto
Ventile plumbeu
Tromba ex corio
P
Alius ventile
L
E
Interior pars undus
E
L

Fig. 3

Part II—Reciprocating Pumps

the History of HYDRAULICS

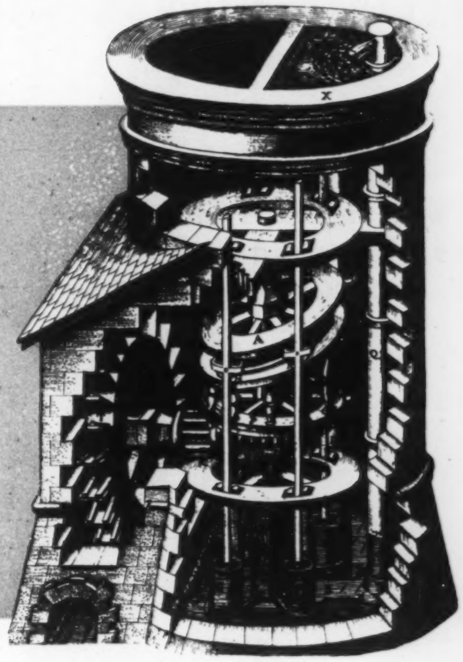


Fig. 5

By H. G. Conway
Technical Director
British Messier Ltd.
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RECIPROCATING piston pumps operated by water wheels were evidently known to the ancient Egyptians long before the time of Christ. Bellows for blowing a fire are equally old and were used by the early Chinese.

A good example of the typical construction of early reciprocating pumps is illustrated in *Fig.* 3, from Robert Fludd's textbook of 1618. The cylinders are collapsible bellows carrying what the modern hydraulic engineer will immediately recognize as inlet and delivery valves, probably of leather. Reciprocation of the bellows, or pistons in the cylinders of earlier types, was effected by projections on a rotating shaft which alternately lifted and released the piston or bellows rods, as in the early type of drop hammer. The weight of the moving assemblies was employed to force the water up the delivery pipe. In the pump illustrated the main shaft is rotated by a water wheel and gear train, although many other means including human power, oxen, dogs or other animals were also used.

There are several early references to a famous water-operated piston pump built by the Roman Ctesibius about the time of Christ, to which had been fitted an air vessel or "accumulator" to smooth out the delivery and render it more or less continuous. There is no doubt that this improvement must have been of very considerable practical benefit but, due no doubt to the difficulties of recording invention and design before the introduction of printing, it appears to have been forgotten and was reinvented much later.

Ramelli in 1588 describes several types of reciprocating pump which even today appear of unusual merit. That shown in *Fig.* 4 has two cylinders, the pistons of which are reciprocated by reversing right and left-hand worms. It will be noted that the worm shaft has two pinions at its upper end which engage alternately with a half set of pin teeth on the wheel being turned by the operator, and which then rotate the worm shaft in alternate directions. This mechanism, a favorite of the ancients, is rare today—perhaps too rare.

What is probably the forerunner of all modern swash plate pumps is shown in *Fig.* 5. The swash plate mechanism itself was known at this time for clock escapements and the pump illustrated was probably devised by Ramelli himself although there is no evidence that it was ever built.

Panel Meter Redesigned

. . . with emphasis on appearance, interchangeability, and production economy

By Bradley Thompson
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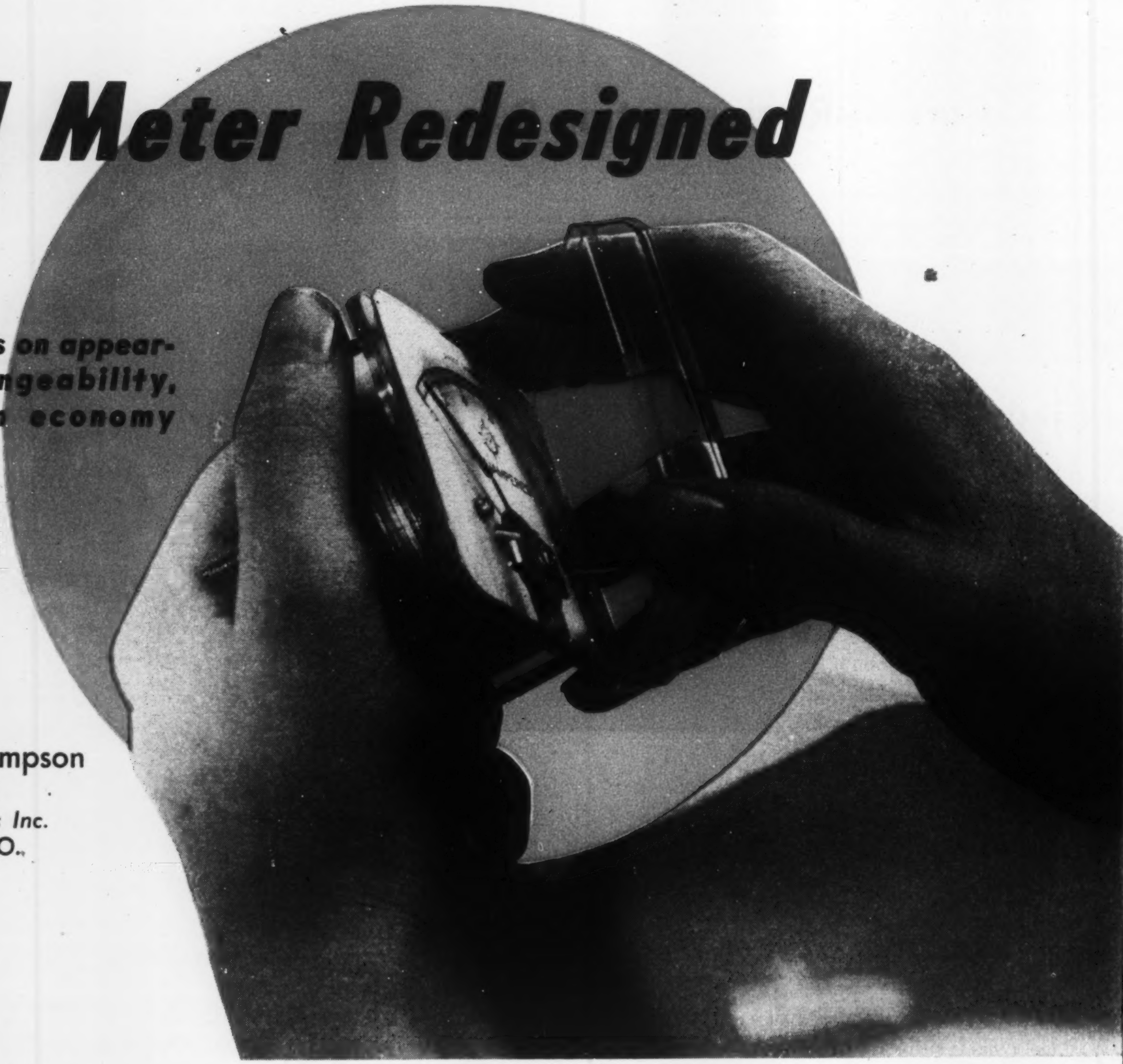

FOR many years the familiar two and one-half inch panel meter has been built to pretty much standard dimensions and style. Our model was hardly distinguishable from the same type meter produced by several companies. Competition has tended to reduce the price, but the twenty-year old design offered few opportunities for additional cost savings. Three years of experimental design with a larger model yielded results, production and saleswise, which strongly favored redesigning of the two and one half inch meter.

REDESIGN OBJECTIVES: Four principle requirements were listed as the primary objectives of the redesign, *Fig.* 2:

1. Better appearance for new sales appeal
2. All possible economies in production to meet the competitive condition of the market for this type and size of instrument
3. Retainment of the same panel mounting dimensions for interchangeability in present designs of equipment where the meter might be used
4. Use of only those materials and methods that have already been given a production test at one time or another in the plant to assure the greatest possible freedom from production bugs and performance defects.

OLD DESIGN: For the purpose of emphasizing the changes involved, a discussion of features of the old meter follows, *Figs.* 2 and 3. The case was made of front and back half pieces of compression-molded phenolic. Like most small panel meters the front half, or case section, had an opening into which a glass window was fitted. To make this dust and moisture proof, some form of putty or other sealing compound was used between the glass and the case, the glass being backed by a metal ring around the outside edge, for mechanical strength. Four screws insert-molded into the front half of the case provided for panel mounting, and three holes radially drilled around the barrel of the front half held the front and back, or base part, together. The base had all necessary projections molded-in to hold the meter movement as well as the terminal screws for electrical connections.

In this design, the scale mounting plate could be no larger than the inside diameter of the barrel of the case. This limited the usable scale space to less than half of the total front area of the meter. Because the scale was mounted behind a relatively small opening in the opaque case, it was difficult to read in a poor light.

New Design: Of utmost importance in the redesign undertaking was the retention of mounting dimensions to make possible easy replacement of old meters. This has made it necessary to keep the same barrel diameter and the same location of panel mounting screws, *Fig.* 2. However, by making the barrel a part of the base, the scale mounting plate has been increased in size to approximately the full area of the meter front. Market research revealed that users of the meter had no objection to increasing the front dimensions slightly, provided the increase did not require a change in the panel mounting holes. By increasing the meter front from two and three-eighths inches square to two and seven-sixteenths inches, the scale arc has been made as large as that used on the average three and one-half inch panel meter—a real sales advantage.

The front is molded of clear plastic for several important reasons. First, utilization of full scale area is possible. None of the scale plate is hidden or shadowed as in the old case. Second, reduction of the piece price for the same number of mold cavities can be attained because of the faster molding cycle. Also, in the matter of assembly, the slow and expensive fitting of the glass window has been eliminated by the clear, less easily broken plastic.

Experiments with several of the clear plastics indicated the most desirable results could be obtained with the new heat-resistant Styrenes. This plastic is readily molded free from flaws and has excellent transparency and dimensional stability at temperatures well above the meter design requirement of 150 F. It is slightly flexible, tough and not easily scratched.

The back part of the case is molded of the same material. By making the back transparent, inspection for defects which might have been hidden within the old opaque case is facilitated, *Fig.* 2. This feature also makes the meter adaptable to rear illumination by use of a translucent dial plate. Even though the outside dimensions of the barrel part of the case have not been increased, more space is available for mounting resistors, rectifiers, etc., because of the thinner wall section required in one-piece construction.

A study of production costs determined that the panel mounting screws should be hot-pressed into the finished case rather than insert-molded. So the mold is built to provide four holes, countersunk and slightly undersize, to take No. 4-40 flat-head screws.

The zero adjuster pin is held by a through-hole in the front case section. Previous experience had shown that it was difficult to mold such a hole in clear plastic without getting weld or flow lines where the material met after flowing around the hole core. Such lines detracted from the appearance of the case. Therefore, the counterbore is molded-in, but the through hole is drilled after molding.

An expensive operation in the old case was the fastening of the front and back case sections with the three radially located screws. To avoid this, snap

Fig. 1—Left—Snap hooks and recesses eliminate need for screws previously employed for fastening front and back case sections

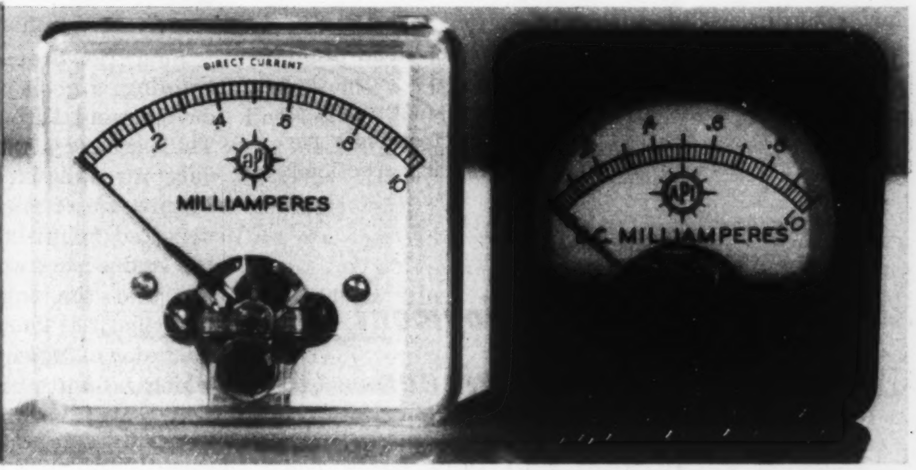

Fig. 2—Right—Comparison views of the new and old designs. Larger scale area and lack of shadow are clearly evident

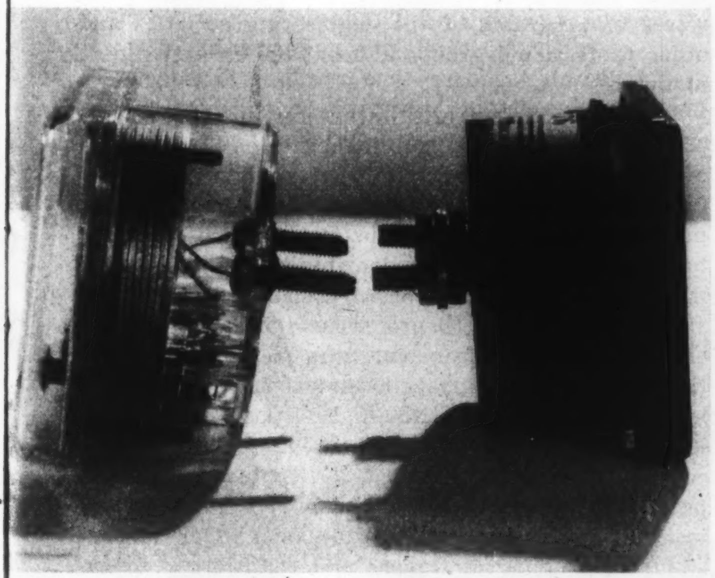

Fig. 3—Comparison views, new and old, illustrating the advantage, inspectionwise, of the clear plastic model. Also evident is the fact that both meters fit in the same panel mounting holes and have the same terminal stud location

hooks and recesses are integrally molded into the case, *Fig.* 1. If a minor adjustment is required on a finished meter the front can be snapped off and replaced in much less time than was required on the old three-screw assembly.

Artists decided that some lines were required in the front to remove the plain appearance. It was felt, however, that the outside front surface should be kept smooth to make wiping clean easier. Both results have been attained by putting the lines on the inside of the front.

The terminal screws hold connection wires or components which must be soldered in place before assembly. For this reason these screws are held in molded recesses by Tinnerman speed nuts, *Fig.* 3, rather than being molded or hot pressed.

RESULTS OF REDESIGN: Results from the redesign have proved most gratifying. The appearance for new sales appeal is there. Several production economies have been realized by the change from compression to injection molding and by the elimination of several parts and expensive assembly operations. The new meter fits in the same panel mounting holes and requires the same space behind the panel. The usable dial plate area and scale arc length are more than doubled. Adherence to materials and methods that have been given thorough production tests has permitted production of the new design with practically no bugs.

Professional Development of the Young Engineer

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INDUSTRY has a special responsibility in the professional development of the young engineer. When a college graduate joins a company, he is making an investment of his time and talents in that organization. His future welfare as well as his usefulness to the company will be determined, in a large measure, by the type of training and guidance he receives. Accordingly, the new recruit has a right to expect his company to make an investment in his training and development.

There are certain basic steps which the young engineer must take before he starts the second mile. You may call these steps preprofessional development, if you wish, but they are related significantly to ultimate success. A professional attitude, like happiness itself, is not something a person strives for, rather, it is a by-product of full participation in worth-while activities—productive labor, the family, and the community.

Too many companies are not giving adequate attention to preparing their people for technical and management positions. However, there is much that industry can do, especially for those who have a capacity for further growth. While individual company requirements vary, there are certain requisites for an effective development program which are worthy of discussion:

Create a proper environment. Effective development requires a favorable atmosphere in which to grow. One of the best ways to develop professional attitudes is through association with men, who, themselves, have a healthful outlook concerning the job, our social institutions, and life in general.

Selection and training. A company cannot long expect to maintain its position in the dynamic business world of today without making adequate provision for bringing in capable young men and developing them for key technical and management positions. Thorough training in fundamentals involves not only a clear understanding of the principles of science and the engineering method, but the capacity to apply them to the solution of everyday problems. But initial training of the more or less formalized type is not enough. There is need for continuous development on an informal basis as the engineer moves along in his career.

Educational opportunities. In addition to follow-up training, a good practice is that of encouraging self-development through courses at a nearby university. The engineer attains the status of a professional man only through experience and continued study. The importance of further study to enable him to recognize and handle the technical and human factors in his engineering work cannot be overstressed. Assuming that the engineer is reasonably well-grounded in scientific knowledge, and, therefore, is able to hold down an engineering job, the major problems which he will encounter will be problems of human and social relations. It would seem then, that the young engineer needs to deepen and broaden his social knowledge and to exercise the art of using it in the solution of everyday problems.

Encourage professional activities. Industry can do much to encourage technical employees to avail themselves of programs of the engineering societies and other professional groups and to take an active part in them.

One of the most fruitful areas for industry-college co-operation is through the inauguration of programs of graduate study for engineers who are engaged full-time in industry. While only the employer can provide orientation to industry and job training, teaching of advanced fundamentals can be handled best by colleges with the active assistance of industry.

The master keys to professional development are embodied in two words: encouragement and recognition. The young engineer needs encouragement if he is to use his abilities at the highest possible level and is to develop his potentialities through experience and education. A pat on the back for a job well-done and promotion for demonstrated ability acts as a powerful incentive to further self-advancement. Our responsibility as industrial leaders and engineering educators is to *point the way.*

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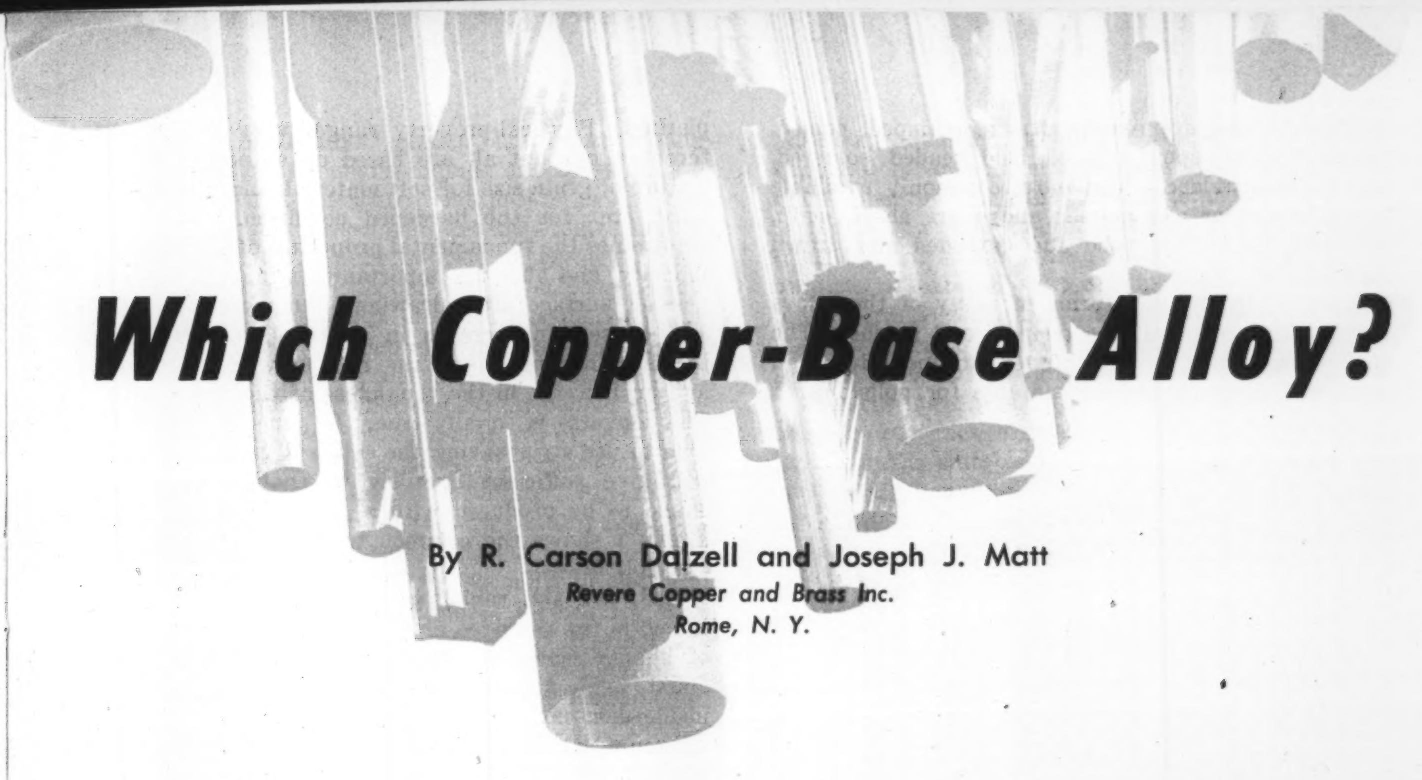
* This article is an abstract of a paper presented at the AIEE Winter General Meeting, New York, Feb. 1949 and published in *Electrical Engineering*, July 1949.



Which Copper-Base Alloy?

By R. Carson Dalzell and Joseph J. Matt

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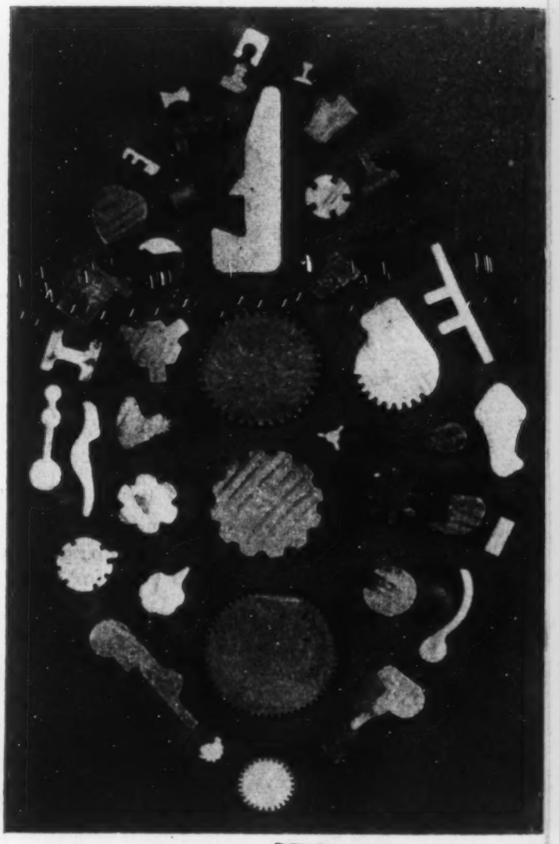
COPPER, one of the oldest metals known to man, has come a long way since the "Bronze Age" of ancient history. Because of its own inherent properties and its alloying qualities with zinc, tin, lead, silver, phosphorus, silicon, nickel, tellurium, arsenic and many other elements, it has shown the versatility necessary to keep in step with the progress made by man in the Machine Age. Its qualities are constantly being improved and expanded by research and experimentation so that today we have multitudinous applications wherein copper and its alloys give superior performance.

Copper and most of its alloys act like a pure metal. They are not heat-treatable—cannot be hardened by application of heat followed by a quench—nor do they become brittle at extremely low temperatures. Hardening is produced by cold working alone, which tends to give a large range of physical properties for each alloy. Softening is produced by annealing above the recrystallization temperature for the required time, but the effect of the rate of cooling after annealing is, with few exceptions, negligible. In most cases annealing is followed by a water quench in order to save time in processing. This property alone lends a great deal to the versatility of copper and its alloys.

Copper-base alloys have excellent ductility, tensile strength, elongation, electrical conductivity, thermal conductivity, and corrosion resistance. Desirable combinations of these properties are secured by selection of chemical composition, grain size and temper. These alloys are highly



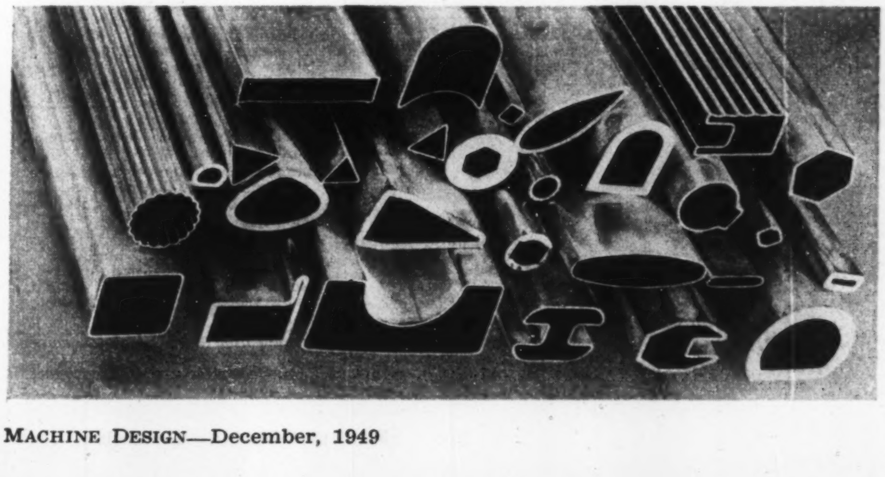


Fig. 1 — Copper-base alloys are available in tubing (left) and bar (above) extruded or drawn to an infinite variety of shapes to specification. Use of such shaped stock can often eliminate a great deal of expensive machining

machinable and are readily drawn, stamped, coined, forged, formed, spun, swaged, cold headed, soldered, brazed, and welded. The most commonly available forms of copper and copper alloys are sheet, strip, roll, rod, bar, plate, tube and extruded and drawn shapes.

Sheet, strip and roll forms of many of the alloys can be obtained in various tempers and finishes. The finishes may vary from embossed, crimped, dull, and satin, to bright dipped, or suitable for polishing or plating. Physical-property ranges vary for the different alloys but all are based on a temper nomenclature of grain size for soft material, and ¼-hard, ½-hard, etc., for the hardened condition. Grain size determines the fundamental properties of ductility and tenacity, and also the important attribute of smoothness of surface after drawing. An increasing grain size causes an increase in ductility, a decrease in tenacity, hardness, and the rate of work hardening, and an increase in the roughness of the drawn parts. The converse is equally true. In general, it is desirable to use strip having the smallest grain size which will give sufficient ductility to enable the desired shape to be produced with a fair margin of safety. TABLE 1 shows the common tempers for sheet, strip and roll brass.

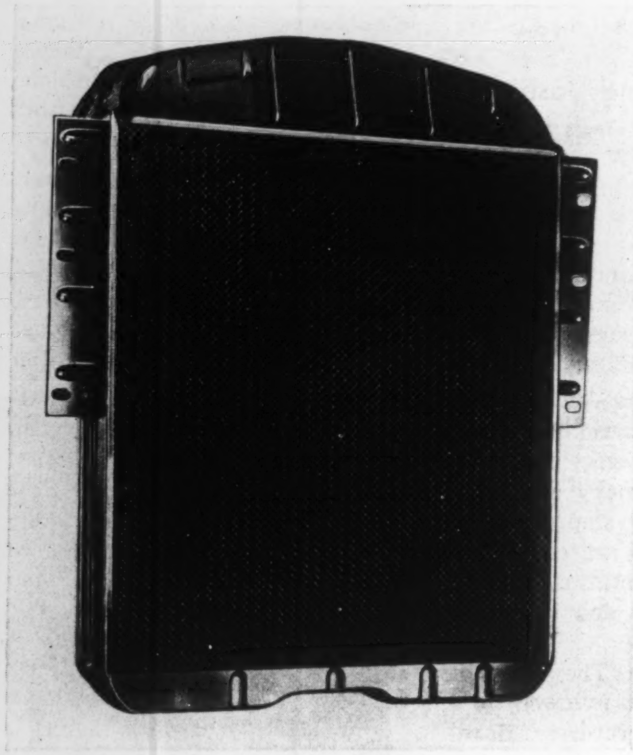
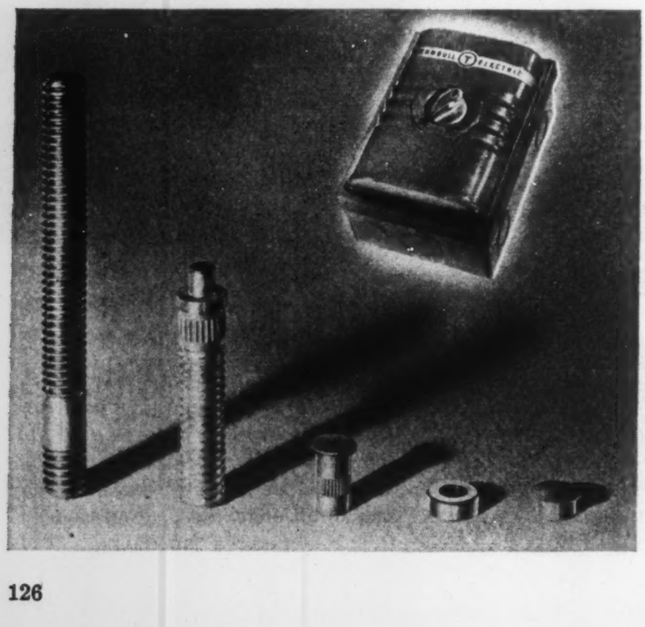


Fig. 2—Above—Silver-bearing copper was selected for this auto radiator because it is easily formed, has high thermal conductivity, is readily soldered without loss of strength, and has good corrosion resistance

Fig. 3—Below—Because of its high conductivity, corrosion resistance, ease of machining, and moderate strength, tellurium copper was used for these electrical switch parts



Rod, bar and tubing of many alloys may be obtained in the extruded or drawn condition in a variety of shapes such as round, square, triangular, hexagonal, oval, fluted, etc. In the case of tubing, the inside does not always have to be the same shape as the outside. Some idea of the wide variety of shapes available may be gleaned from *Fig.* 1.

Copper's electrical and thermal conductivity, surpassed only slightly by silver, are practically double that of any other commercial metal. But in instances where these qualities are undesirable, they can be suppressed by suitable alloying elements. The corrosion resistance of copper is, of course, well known. Admiralty metal received its name from its use as condenser tube by the British Admiralty in its ships' condensers. Muntz metal, red brass, and arsenical copper have long been used for their resistance to mild corrosive conditions. The cupro-nickels, aluminum bronzes, and aluminum brass are modern alloys developed to meet severe corrosive conditions.

Copper and its alloys are nonmagnetic, an advantage in many electrical and electronic fields. Further, being nonsparking, they are naturally preferred where sparking would be dangerous, such as machine ap-

Table 1—Tempers and Formability of Brass Sheet, Strip and Roll

Temper Designation	Formability
Annealed (soft) Metal*	
Extra deep-drawing anneal (over 0.050-mm average diameter grains)	Special cases of deep drawing and spinning. Rough surface on drawn parts not suitable for polishing
Deep-drawing anneal (0.040-0.050-mm average diameter grains)	Common soft temper for deep drawing and spinning. Surface on drawn parts suitable for most polishing requirements
Light anneal (0.015-0.040-mm average diameter grains)	Special soft temper used for moderate drawing and cupping. Drawn part surfaces suitable for polishing
Hard (cold-rolled) Metal**	
¼-hard	Special hard temper suitable for shallow forming
½-hard	Common hard temper suitable for sharp 90-degree bends. Slight radius required for leaded brasses
¾-hard, Full-hard, Extra hard, Spring, and Extra spring tempers	These and foregoing hard tempers have good blanking, shearing and machining characteristics. Magnitude of bend radii increases with hardness

* Recrystallized grains, produced by annealing hard metal at temperatures from 600 to 1200 F.

** Distorted and broken-up grains, produced by cold rolling soft metal to finish thickness.

plications in flour mills, powder plants and installations handling inflammable liquids or vapors.

COPPERS: Characteristics and properties of some of the more popular coppers are listed in TABLE 2.

Electrolytic tough-pitch copper, oxygen-free, high-conductivity (OFHC) copper and silver-bearing copper, because of their high electrical conductivity, are used as electrical conductors, bus bars, commutator segments, electric wires and cables, and in electronic tubes and equipment. Silver-bearing copper is preferred in instances where temperatures of 500 to 700 F occur, since the silver raises the annealing temperatures, thereby retarding softening. Silver-bearing copper is recommended for commutator segments or heat transfer units where soldering is employed or high temperatures are used in assembly, in electrical contacts or circuit breakers where momentary high temperatures exist, or in electrical or thermal apparatus employed at relatively high temperatures, such as spark plug gaskets, etc. When assembly of an article requires welding or brazing, deoxidized copper is recommended since it is not subject to embrittlement by reducing gases at high temperatures.

The auto radiator shown in *Fig.* 2 is an example of the use of silver-bearing copper. This application requires a material that can be easily formed, has high thermal conductivity, is easily soldered with no loss in strength due to annealing at the soldering temperature, and has good corrosion resistance.

Free-cutting or tellurium copper has excellent machining properties, high electrical and thermal conductivity, and is suitable for swaging or forging. Some of the main uses for free-cutting copper are cutting-torch tips and copper studs and bolts. *Fig.* 3 shows a few parts made from tellurium copper for an electrical switch. This application required high conductivity, corrosion resistance, ease in machining, and moderate strength. Other representative applications of coppers are listed in TABLE 2.

In the correct tempers, coppers are suitable for deep

Table 2—Characteristics, Uses and Properties of Coppers

Characteristics, Uses and Properties	**Electrolytic Tough Pitch**		**Deoxidized**		**Oxygen-Free High Conductivity**		**Silver-bearing**		**Arsenical Phosphorized**		**Free-Cutting Copper**	
Typical Uses	Forgings, printing rolls, electrical conductors, commutators, kettles, vats, etc.		Water and refrigeration equipment tubes, heat exchanger tubes, welded sheet and plate construction		Special drawn and stamped parts; for sealing to glass; electrical equipment at high temperatures in reducing gases		Electrical commutators, automotive radiators; where strength is required at moderately high temperatures		Certain condenser and heat exchanger applications		Screw machine parts, electrical equipment, welding torch tips, interior parts for vacuum tubes	
Characteristics	High electrical conductivity; high thermal conductivity; excellent workability		Better forming and bending qualities than electrolytic copper; preferred for coppersmithing and welding		Excellent for deep drawing; superior glass-to-metal seals; high electrical conductivity		High electrical conductivity; resists softening at temperatures from 500 to 700 F		Low electrical conductivity; special corrosion-resistance properties		High electrical conductivity; high thermal conductivity; similar to oxygen-free, high-conductivity copper but free cutting	
Working Properties												
Cold-working	Excellent		Excellent		Excellent		Excellent		Excellent		Good	
Hot-working	Excellent		Excellent		Excellent		Excellent		Excellent		Good	
Machining	Fair		Poor		Poor		Fair		Poor		Excellent	
Welding*	Deoxidized copper preferred		Gas, carbon-arc, metal-arc		Carbon-arc, metal-arc		Deoxidized copper preferred		Gas, metal-arc, carbon-arc		Not recommended	
Soldering	Excellent		Excellent		Excellent		Excellent		Excellent		Good	
Polishing	Excellent		Excellent		Excellent		Excellent		Excellent		Excellent	
Weight (lb per cu in.)	0.322		0.323		0.323		0.322		0.323		0.323	
Modulus of Elasticity (psi)	17,000,000		17,000,000		17,000,000		17,000,000		17,000,000		17,000,000	
Coef. of Thermal Expansion (average, per deg F from 68 to 570 F)	0.0000098		0.0000098		0.0000098		0.0000098		0.0000096		0.0000098	
Electrical Conductivity (% IACS at 68 F)	101 (annealed)		85 (annealed)		100 min.		100 min.		45		90 min.	
Thermal Conductivity (Btu/sq ft/ft/hr/deg F at 68 F)	226		196		227		227		102		205	
Tensile Strength (thousands psi)	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft
Sheet	50	32	55	32	50	32	52	33	..	..	..	..
Rod	48	32	..	..	..	..	..	..	..	..	53	32
Tube	55	32	55	32	..	..	..	..	60	37	..	..
Elongation in 2 in. (%)												
Sheet	6	45	5	45	5	40	5	40	..	..	..	..
Rod	16	55	..	..	..	..	..	..	..	..	7	40
Tube	8	45	8	45	..	..	..	..	4	42	..	..
Yield Strength (0.5% extension, thousands psi)												
Sheet	45	10	42	10	48	8	48	7	..	..	..	..
Rod	44	10	..	..	..	..	..	..	..	..	49	7
Tube	50	10	50	10	..	..	..	..	48	8	..	..
Rockwell Hardness												
Sheet	50B	40F	50B	40F	50B	40F	55B	40F	..	..	..	..
Rod	47B	40F	..	..	..	..	..	..	..	..	45B	40F
Tube	60B	40F	60B	40F	..	..	..	..	95F	28F	..	..

* Conductivity of coppers makes resistance welding (spot and seam) impractical. Coppers may be brazed, however, by a patented method.

drawing, spinning, forming, cold heading, stamping, coining, embossing, bulging and blanking.

Brasses: These well-known alloys of copper and zinc are used in practically every industry and are the best known of all the copper alloys. By selection of the proper alloy, the designer secures higher tensile and yield strength, greater elongation or hardness, better corrosion resistance to certain environments, or suitable color.

Because of the high ductility and malleability of the brasses, with their low work-hardening rate (which reduces or eliminates the necessity of intermediate anneals), they are especially suitable and economical in cases involving a great amount of deformation, as in deep drawing. Tables 3, 4 and 5 show some of the properties of the most common brasses along with a number of representative applications. There is a brass for practically any spinning, forming, bending, stamping, drawing, plating or welding application.

Since cartridge brass has the best combination of ductility and strength of all the brasses it was chosen for those applications shown in *Fig.* 4, where deep draws and high strength are required. By using this material in the annealed temper with a grain size of 0.040 to 0.050-mm, deep draws were possible without sacrificing a smooth surface suitable for polishing or plating. Intermediate anneals were necessary, however, between some of the draws of the deep cylindrical articles shown in the left of *Fig.* 4. By closely controlling these anneals, grain growth was not experienced and the smooth surface was retained. In applications where a smooth surface is not as critical, material may be used having a larger grain size en-

Table 3—Characteristics, Uses and Properties of Brasses

Characteristics, Uses and Properties	Gilding, 95%		Commercial Bronze, 90%		Red Brass, 85% (Rich Low Brass)		Low Brass, 80% (Red Brass, 80%)		Cartridge Brass, 70%		Yellow Brass		Muntz Metal (Yellow Metal)	
Typical Uses	As base for parts to be gold plated or highly polished		Forgings, screws, weatherstripping, stamped hardware		Automobile radiators, tube and pipe for oil and utility fields and plumbing		Thermostat bellows, deep-drawn parts		Cartridge cases and ammunition components		For parts produced by practically all processes: pins, rivets, eyelets, etc.		Condenser tubes valve stems, brazing rods	
Characteristics	Compared to copper has higher tensile strength, equal ductility, lower thermal properties; golden color		Excellent cold-working properties, very ductile		Higher strength and ductility than copper, excellent corrosion resistance; better at high temperatures than higher zinc alloys		Similar to 85% Red Brass		Best combination of ductility and strength of any brass; excellent cold-working properties		Excellent cold-working properties combined with good corrosion resistance on par with Cartridge Brass		High strength combined with low ductility	
Working Properties														
Cold-working	Excellent		Excellent		Excellent		Excellent		Excellent		Excellent		Fair	
Hot-working	Excellent		Excellent		Good		Good		Good		Poor		Excellent	
Machining	Poor		Poor		Poor		Poor		Fair		Fair		Good	
Welding	Gas, carbon-arc, metal-arc		Gas, carbon-arc metal-arc		*		*		*		*		*	
Soldering	Excellent		Excellent		Excellent		Excellent		Excellent		Excellent		Excellent	
Polishing	Excellent		Excellent		Excellent		Excellent		Excellent		Excellent		Excellent	
Weight (lb per cu in.)	0.320		0.318		0.316		0.313		0.308		0.306		0.303	
Modulus of Elasticity (psi)	17,000,000		17,000,000		17,000,000		16,000,000		16,000,000		15,000,000		15,000,000	
Coef. of Thermal Expansion (average, per deg F from 68 to 570 F)	0.0000100		0.0000102		0.0000104		0.0000106		0.0000111		0.0000113		0.0000116	
Electrical Conductivity (% IACS at 68 F)	56		44		37		32		28		27		28	
Thermal Conductivity (Btu/sq ft/ft/hr/deg F at 68 F)	135		109		92		81		70		67		71	
Tensile Strength (thousands psi)	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft
Sheet	56	34	61	37	70	40	74	44	76	47	74	47	80	54
Rod	..	..	60	40	57	40	65	43	70	48	60	48	75	54
Tube	..	..	..	38	70	40	89	43	78	47	..	..	74	56
Elongation in 2 in. (%)														
Sheet	5	45	5	45	5	47	7	50	8	62	8	62	10	45
Rod	..	..	20	50	23	55	20	60	30	65	25	65	20	50
Tube	..	..	..	50	8	55	5	45	8	65	..	..	10	50
Yield Strength (0.5% extension, thousands psi)														
Sheet	50	10	54	10	57	12	59	14	63	15	60	15	60	21
Rod	..	..	55	10	52	10	55	12	52	16	45	16	55	21
Tube	..	..	..	12	58	12	55	12	64	15	..	..	55	23
Rockwell Hardness														
Sheet	64B	46F	70B	53F	77B	59F	82B	61F	82B	64F	80B	64F	85B	80F
Rod	..	..	60B	55F	75B	55F	75B	65F	80B	65F	70B	65F	80B	80F
Tube	..	..	..	57F	77B	60F	85B	60F	82B	64F	..	..	80B	82F

* Gas, carbon-arc, metal-arc, spot and seam welding for thin gages.

abling deeper draws to be made between anneals, or possibly without annealing.

The leaded brasses listed in TABLE 4 are the free-machining varieties of copper alloys. Lead is not dissolved in the brass but is finely distributed throughout the metal in microscopic particles. These lead particles reduce friction while machining, by causing chips to break off short; consequently, they are in only momentary contact with the cutting edge of the tool. This action greatly increases the useful life of the tool.

Free-cutting brass is the favorite of screw machine operators and is ideal for any machining requirements in rod form. This metal, in spite of its increased machinability, is strong. It can be cut, roll threaded, drilled and tapped, milled, broached, and sawed, with no appreciable burrs.

High-leaded brass, or engraver's brass, is used for flat products that require routing, milling, turning or blanking. It is used extensively by printers and engravers for plates because of its clean machining characteristics, leaving no burrs or rough areas that would prove to be detrimental in printing. When blanking this material, closer die clearances should be employed than for any of the nonleaded alloys. These smaller clearances enable closer tolerances to be maintained on the part being blanked and often eliminate the necessity of deburring edges or reaming holes or notches.

Low-leaded brass tube is recommended for tubular designs necessitating an appreciable amount of machining, such as bushings, washers, and collars.

Free-cutting brass rod and leaded brass tube produce savings in making possible adequate quality at low-cost, high-production rates, longer tool life, and less machine maintenance. Leaded brass tube can be obtained in a multitude of shapes, with hexagon, square, fluted or irregular-shaped outside and inside surfaces, or combinations of these. *Fig.* 5 shows some screw machine parts which were made from both tube and rod.

The clock shown in *Fig.* 6 employs leaded brass for flat parts that are machined or blanked, such as gears, plates, backs and bases; free-cutting brass for machined items made from rod, as bearings, screws, bolts, hubs, collets, etc.; and cartridge brass for drawn or formed parts, such as cases, bezels, covers, hands, dials and molding. Phosphor bronze is used for many of the springs, washers and bushings.

Tin brasses have been best known for their corro-

Table 4—Characteristics, Uses and Properties of Leaded Brasses

Characteristics, Uses and Properties	**Low-Leaded Brass** (Tube)		**High-Leaded Brass** (Engravers' Brass)		**Free-cutting Brass**		**Forging Brass**		**Architectural Bronze**	
Typical Uses	Screw machine parts, electrical fuse parts, pipe, pump liners		Instrument parts, lock parts, gears, nameplates, watch parts		Screw machine parts		Hot forgings, plumbing, hardware		Industrial extruded shapes: hinges, lock bodies, automotive parts	
Characteristics	Free machining combined with moderate cold-forming ability		Free machining and good blanking		Excellent machinability, good mechanical and corrosion resistance properties		Extremely plastic hot; good corrosion resistance, excellent mechanical properties		Excellent forging and free machining properties	
Working Properties										
Cold-working	Fair		Poor		Poor		Fair		Very poor	
Hot-working	Poor		Poor		Good		Excellent		Excellent	
Machining	Good		Excellent		Excellent		Good		Good	
Welding	Nonleaded brass preferred		Nonleaded brass preferred		Nonleaded brass preferred		Nonleaded brass preferred		Poor	
Soldering	Excellent		Excellent		Good		Good		Excellent	
Polishing	Excellent		Excellent		Excellent		Excellent		Excellent	
Weight (lb per cu in.)	0.307		0.306		0.307		0.305		0.305	
Modulus of Elasticity (psi)	15,000,000		15,000,000		14,000,000		15,000,000		14,000,000	
Coef. of Thermal Expansion (average, per deg F from 68 to 570 F)	0.0000112		0.0000113		0.0000114		0.0000115		0.0000116	
Electrical Conductivity (% IACS at 68 F)	26		26		26		27		28	
Thermal Conductivity (Btu/sq ft/ft/hr/deg F at 68 F)	67		67		67		69		71	
Tensile Strength (thousands psi)	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft
Sheet	..	..	74	49	..	..	..	..	..	..
Rod	..	..	..	..	58	49	..	52	..	60
Tube	75	47	..	..	..	..	..	..	..	..
Elongation in 2 in. (%)										
Sheet	..	..	7	52	..	..	..	..	..	..
Rod	..	..	..	..	25	53	..	45	..	30
Tube	7	60	..	..	..	..	..	..	..	..
Yield Strength (0.5% extension, thousands psi)										
Sheet	..	..	60	17	..	..	..	..	..	..
Rod	..	..	..	..	45	18	..	20	..	20
Tube	60	15	..	..	..	..	..	..	..	..
Rockwell Hardness										
Sheet	..	..	80B	68F	..	..	..	..	..	..
Rod	..	..	..	..	78B	68F	..	78F	..	65B
Tube	80B	64F	..	..	..	..	..	..	..	..

sion resistance in condensers and heat exchangers. In recent years, however, has come realization that the alloying of small amounts of tin in various strip alloys enhances spring properties.

Naval brass and Roman bronze have long been popular for pump shafts and piston rods. Screw machine parts such as marine hardware requiring the corrosion resistance of naval brass are better made with a leaded naval brass if a slight sacrifice in physical properties can be tolerated. However, the unleaded variety machines well.

Manganese bronze has the highest mechanical properties of all the brasses, together with good abrasion and corrosion resistance. Typical uses are in valve stems, slotted or perforated screens, bolts, valve seats, dies, clutch disks and springs.

All brasses containing about 60 per cent copper have excellent forging and hot working properties. Consideration should be given to fabrication by forging if fairly heavy walls can be tolerated. One forging operation may produce a part that would require several cold draws. The part will be stronger than a drawn article, both because of the heavier sections and because these hot working alloys are fundamentally high strength mixtures. Forging is sometimes referred to as "plastic machining" in recognition of the complicated surfaces that may be generated in the one operation. A forging has, of course, the additional features of smooth surface, freedom from porosity, etc., which mean low finishing costs comparable to die castings. When designing brass parts the designer should consider the overall cost of manufacture by forging, cold forming, casting, machining from bar stock, and possibly simpler machining from extruded shapes. Typical finished and semifinished parts where forging proved to be the most economical method of manufacture are shown in the photograph, *Fig.* 7

BRONZES: Properties and characteristics of the most common bronzes are listed in TABLE 6. Tin bronzes, or so-called phosphor bronzes (because they are deoxidized by phosphorus), have superior fatigue and abrasion resistance properties, and produce excellent springs having long life and tarnish resist-

Table 5—Characteristics, Uses and Properties of Tin Brasses

Characteristics, Uses and Properties	**Chain Bronze**		**Admiralty**		**Roman Bronze**		**Naval Brass**		**Leaded Naval Brass**		**Manganese Bronze (A)**	
Typical Uses	Chains		Condenser and heat exchanger plates and tubes, marine uses, automobile aerials		Propeller and pump shafts, piston rods, marine uses		Tube sheets in heat exchangers and steam condensers, hot-worked forgings		Screw machine parts, forgings, bolts, marine hardware		Forgings, condenser plates, valve stems, coal screens	
Characteristics	Combines strength and ductility		Excellent corrosion resistance, strength and ductility		Fine, uniform grain structure; high resistance to fatigue and salt water corrosion		Resistant to salt water corrosion; for moderate cold-working operations		Similar to Free-Cutting Brass but with increased strength and corrosion resistance		High strength combined with excellent wear resistance	
Working Properties												
Cold-working	Good		Good		Fair		Fair		Poor		Poor	
Hot-working	Fair		Poor		Excellent		Excellent		Good		Excellent	
Machining	Poor		Fair		Good		Good		Excellent		Good	
Welding	....		Gas, carbon-arc		*		*		Nonleaded brass preferred		*	
Soldering	Excellent		Good		Excellent		Excellent		Good		Excellent	
Polishing	Excellent		Good		Excellent		Excellent		Excellent		Excellent	
Weight (lb per cu in.)	0.317		0.308		0.304		0.304		0.305		0.302	
Modulus of Elasticity (psi)	15,000,000		16,000,000		15,000,000		15,000,000		15,000,000		15,000,000	
Coef. of Thermal Expansion (average, per deg F from 68 to 570 F)	0.0000104		0.0000112		0.0000119		0.0000118		0.0000118		0.0000118	
Electrical Conductivity (% IACS at 68 F)	30		25		26		26		26		24	
Thermal Conductivity (Btu/sq ft/ft/hr/deg F at 68 F)	81		64		67		67		67		61	
Tensile Strength (thousands psi)	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft
Sheet	67	45	85	50	..	..	90	58	90	58	..	..
Rod	..	..	..	..	82	60	75	57	75	57	84	65
Tube	..	..	100	53	..	..	88	..	..	..	..	..
Elongation in 2 in. (%)												
Sheet	5	45	5	55	..	..	5	40	5	35	..	..
Rod	..	..	..	..	20	45	20	47	15	40	19	33
Tube	..	..	3	65	..	..	18	..	..	..	..	..
Yield Strength (0.5% extension, thousands psi)												
Sheet	50	12	70	18	..	..	70	20	70	20	..	..
Rod	..	..	..	..	55	22	53	25	53	25	60	30
Tube	..	..	80	22	..	..	66	..	..	..	..	..
Rockwell Hardness												
Sheet	80B	60F	90B	25B	..	..	90B	45B	90B	45B	..	..
Rod	..	..	..	..	80B	50B	82B	55B	82B	55B	90B	65B
Tube	..	..	95B	75F	..	..	95B	..	..	..	..	..

* Gas, carbon-arc and metal-arc. For thin gages, spot and seam welding.

ance. They are employed in innumerable spring applications, including diaphragms, bellows, lock washers, latches, relay parts, flexible hose, etc. They are essential in many machines, instruments, etc., in the paper mill, oil well, textile, leather, laundry, pump, printing, refrigeration, electrical, marine and automotive industries. Because of their wear properties, these alloys are also used as wear plates, thrust washers, and clutch disks. They have high tensile strength, excellent corrosion resistance, fair electrical conductivity, and easy workability.

Phosphor bronze was picked for the application shown in *Fig.* 8 because of its high strength, fatigue resistance, corrosion resistance, ease of welding, and easy workability. It assures extreme flexibility, long life, resistance to prolonged vibration, and resistance to contraction and expansion stresses caused by temperature changes.

Aluminum Bronzes High in Many Properties

Aluminum bronzes, because of their excellent corrosion resistance, are used for condenser tubes, for marine equipment such as pump housings, pump rods and shafts, valve fittings, valve stems, nuts and bolts, propellers, and marine trim. Wheels, spindles and other fittings of sluice gates and other harbor equipment are also made of these alloys. Chemical and related industries use the aluminum bronze alloys for pickling crates, chains, and hooks for use with sulphuric, hydrochloric and other acids. Pump bodies, impeller blades, and other working parts in contact with acid or acid fumes, such as fans, are made of these alloys. Aluminum bronzes have proven their worth in contact with hydrofluoric acid, being used in washing machines for bottles that have been etched in this acid. They are used extensively for beater bars and blades in wood pulp machines, where they may be subjected to sulphite and other oxidizing agents in severe abrasive conditions.

Because aluminum bronzes have good heat resisting qualities, they are used for valve seats and guides, spark plugs, and even cylinder heads in some types of internal combustion engines. They do not tend to form oxides which flake off.

Excellent resistance to wear and high mechanical strength make aluminum bronzes particularly suitable for heavy-duty bearings, gears, worm nuts and wheels, selector forks on automotive transmissions and machine tools, and roller bearing cages. They may be used for drill-jig and boring-bar guide bushings, turntable roller bushings in excavating machinery and cranes, nonsparking tools, aligning plates for machines, and screw-down nuts on rolling mills.

Aluminum bronze alloys that are susceptible to hardening by heat treatment are also available, principally as hot forging alloys.

SILICON BRONZES: These alloys have mechanical properties comparable to mild steel plus corrosion resistance comparable to that of copper. In addition, they possess exceptional toughness, high resistance to shock or impact loading, excellent fatigue strength, and are nonmagnetic.

High-silicon bronze is used in making unfired pres-

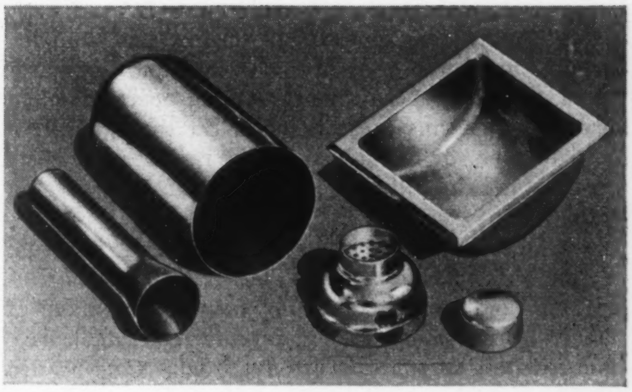


Fig. 4—Above—Where ductility and strength are required, as in the production of these deep-drawn parts, cartridge brass is indicated

Fig. 5—Below—Use of free-cutting brass rod and tube makes possible minimum-cost production of a wide variety of screw machine parts such as these

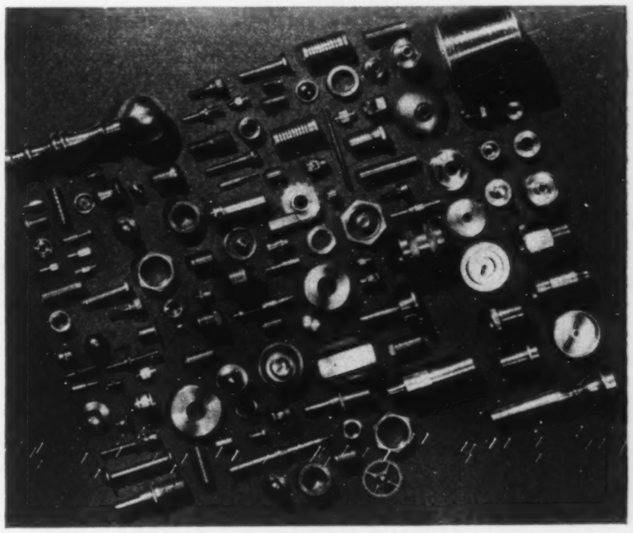


Fig. 6—Below—Many different copper-base alloys are used for parts of this clock, including gears, plates, bearings, screws, case, hands, dial, and molding

sure vessels with steam pressures up to 125 psi, vats, fire extinguishers, centrifugal drying and laundry baskets, hydraulic pressure systems, and in water works, sewage disposal plants, mining operations and general engineering projects where the savings caused by reductions in maintenance and replacement costs are substantial. Silicon bronzes are excellent forging metals.

Low-silicon bronze is usually specified for cold working. Bolts, nuts, screws, lag screws, rivets, cotter pins, and similar fastening devices are made of silicon bronze where strong, fatigue resisting, corrosion resisting properties are required. Cold-headed bolts and screws can be made with tensile strengths up to 110,000 psi, depending on size and shape. Elongation in 2 inches varies from 8 to 30 per cent. Endurance limit (100,000,000 cycles) is between 25,000 and 30,000 psi. Hot-headed bolts can be made with a minimum strength of 65,000 psi. Bolts may be bent from 90 to 180 degrees or given four to ten twists in 10 inches, depending on temper.

Silicon bronze's high strength, good wear and corrosion resistance, cold working and forging properties all make it a favorite in the manufacture of valves. Since the bodies, stems, disks, seats, bonnets and nuts can all be made of the same material, the danger of corrosion by electrolytic action is avoided. Silicon bronze is also used extensively for the manufacture of hot water tanks. Used in the cold-rolled condition, it lends high strength to the vessel and permits light gages to be used. It is readily welded by the carbon-arc or inert-gas, shielded-arc processes. Its excellent corrosion resistance gives reasonable life and trouble-free service in waters too corrosive for steel.

Table 6—Characteristics, Uses and Properties of Bronzes

Characteristics, Uses and Properties	Aluminum Bronzes				Tin Bronzes						Silicon Bronzes			
	Aluminum Bronze, 5%		Aluminum-Silicon Bronze		Phosphor Bronze 5% (A)		Phosphor Bronze 8% (C)		Bearing Bronze		High-Silicon Bronze (A)		Low-Silicon Bronze (B)	
Typical Uses	Condenser tubes, high-strength forgings, tie bolts		Bolts, nuts, gears, pinions, valve bushings, valve bodies and stems		Diaphragms, bellows, washers, cotter pins, clutch disks, springs, screw machine parts		Springs, perforated sheets, bellows, cotter pins, fuse clips, bushings and lock washers		Bushing material for light loads, weatherstrip applications, fuse clips, lamp connections		Tanks, marine construction, weatherstrips, forgings, conduits, hydraulic pressure lines		Cold-headed bolts, nuts, screws, hydraulic pressure line, cotter pins	
Characteristics	High physical properties, high resistance to acids; most resistant of bronzes to H_2S		High tensile strength, excellent corrosion resistance, readily hot-forged, rolled and extruded, free machining		High tensile strength, high resistance to corrosion and fatigue, low friction coefficient, high immunity to season cracking		Corrosion and fatigue resistance high, friction coefficient low, high tensile strength		High physical properties, resistant to atmospheric corrosion and tarnish, low friction coefficient		Corrosion resistance of copper, mechanical properties of mild steel		Tensile properties comparable to cartride brass, corrosion resistance similar to that of copper; welding properties good; nonmagnetic	
Working Properties														
Cold-working	Good		Poor		Excellent		Excellent		Excellent		Good		Excellent	
Hot-working	Good		Excellent		Poor		Poor		Excellent if lead-free		Excellent		Excellent	
Machining	Fair		Excellent		Fair		Fair		Fair		Fair		Fair	
Welding	Gas, carbon-arc, metal-arc		Gas, carbon-arc, metal-arc		Gas, carbon-arc, metal-arc*		Gas, carbon-arc, metal-arc*		Gas, carbon arc, metal-arc		Gas, carbon arc, metal-arc*		Gas, carbon arc, metal-arc*	
Soldering	Good		Fair		Excellent		Excellent		Excellent		Excellent		Excellent	
Polishing	Good		Excellent		Excellent		Excellent		Excellent		Good		Fair	
Weight (lb per cu in.)	0.295		0.278		0.320		0.318		0.315		0.308		0.316	
Modulus of Elasticity (psi)	17,000,000		14,000,000		16,000,000		16,000,000		15,000,000		17,000,000		17,000,000	
Coef. of Thermal Expansion (average, per deg F from 68 to 570 F)	0.0000099		0.0000092		0.0000099		0.0000101		0.0000102		0.0000100		0.0000099	
Electrical Conductivity (% IACS at 68 F)	18		7		18		13		39		7		12	
Thermal Conductivity (Btu/sq ft/ft/hr/deg F at 68 F)	48		22		47		36		100		21		33	
Tensile Strength (thousands psi)	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft
Sheet	..	..	..	..	81	47	93	55	65	45	94	60	65	45
Rod	85	65	95	85	70	..	..	..	..	..	92	58	70	45
Tube	70	50	..	..	..	..	..	..	..	..	..	..	65	45
Elongation in 2 in. (%)														
Sheet	..	64	..	..	10	64	10	70	5	42	8	60	8	45
Rod	20	60	25	35	25	..	..	..	..	..	22	60	15	60
Tube	25	60	..	..	..	..	..	..	..	..	..	..	20	55
Yield Strength (0.5% extension, thousands psi)														
Sheet	..	..	..	..	75	19	2	..	57	10	58	25	50	15
Rod	55	20	53	43	58	..	..	..	..	..	55	22	55	15
Tube	..	..	..	..	..	..	..	..	..	..	..	..	40	20
Rockwell Hardness														
Sheet	..	72F	..	..	87B	73F	93B	75F	76B	55F	93B	85F	77B	60F
Rod	85B	40B	82B	75B	78B	..	..	..	..	..	90B	60B	80B	60F
Tube	80B	55F	..	..	..	..	..	..	..	..	..	..	75B	68F

* For thin gages, spot and seam welding.

COPPER-NICKEL ALLOYS: Alloys of copper and nickel are divided into two basic groups: cupro-nickels and nickel silvers (copper-nickel-zinc alloys). Characteristics, uses and properties of both groups are covered in TABLE 7.

Cupro-nickels have both high corrosion and erosion resisting properties, being used mainly in installations subject to impingement types of attack. They are the most resistant of the copper alloys to stress corrosion and corrosion fatigue types of failure and exhibit superior results in contact with corrosive media where vibrations or stresses occur. They are used as condenser tubes and plates, bolts, nuts and screws, as ammunition components, process equipment, automotive parts, meters, and refrigerator valves.

Attractive color is an outstanding quality of nickel silvers. Varying amounts of nickel give a range of tinges including blue-white, greenish, pink and yellow-white. The nickel improves the mechanical properties of copper and greatly increases corrosion and tarnish resistance. Lead may be added to improve the machining, blanking and shearing properties. Nickel silvers are used in quality fishing reels, rivets, screws, truss wire, zippers, optical goods, etching stock, nameplates and radio dials.

Numerous spring applications employ nickel silver because of its high endurance strength, pleasing appearance, resistance to corrosion and low electrical conductivity. These properties combined with a relatively high modulus of elasticity particularly fill the requirements for strong, exposed springs. Ease of blanking and coining combined with high strength,

Table 7—Characteristics, Uses and Properties of Copper-Nickel Alloys

Characteristics, Uses and Properties	Nickel Silver, 18% (A) (Deep Drawing)		Nickel Silver, 18% (B) (Spring Stock)		Nickel Silver, 15%		Nickel Silver, 10%		Nickel Silver, 5%		Nickel Silver, Leaded		Cupro-Nickel, 30%	
Typical Uses	Extruded shapes, camera parts, various equipment in the process industries, slide fasteners		Springs, extruded shapes, equipment in process industries		Matching complementary trim		Stampings, embossings, decorative trim		Color, decorative trim		Products requiring machinability, lock washers, cotter pins, fuse clips		Condenser tubes and plates, tanks, vats, vessels, automotive parts, nuts, bolts, screws, refrigerator pump valves	
Characteristics	High physical properties, high resistance to corrosion and tarnish, malleable and ductile. Color: silver-blue-white		High physical properties, high resistance to corrosion and tarnish, high fatigue strength. Color: blue-white		High physical properties, high resistance to corrosion and tarnish, malleable and ductile. Color: white		Ductile, good deep drawing properties. Color: yellow-white		Ductile, good deep drawing properties. Color: yellow-white		Good machinability. Prefer nonleaded for bending and drawing. Color: white		High strength, high ductility, resistant to corrosion and erosion. Color: white-silver	
Working Properties														
Cold-working	Excellent		Good		Good		Excellent		Excellent		Poor		Excellent	
Hot-working	Fair		Fair		Fair		Fair		Fair		Fair		Fair	
Machining	Fair		Fair		Fair		Fair		Fair		Excellent		Fair	
Welding	*		*		*		*		*		Nonleaded preferred		Gas, metal-arc, resistance	
Soldering	Excellent		Excellent		Excellent		Excellent		Excellent		Excellent		Excellent	
Polishing	Excellent		Excellent		Excellent		Excellent		Excellent		Excellent		Good	
Weight (lb per cu in.)	0.316		0.314		0.314		0.313		0.308		0.314		0.323	
Modulus of Elasticity (psi)	18,000,000		18,000,000		18,000,000		17,000,000		16,000,000		17,000,000		22,000,000	
Coef. of Thermal Expansion (average, per deg F from 68 to 570 F)	0.0000090		0.0000093		0.0000083		0.0000083		....		0.0000083		0.0000090	
Electrical Conductivity (% IACS at 68 F	6		5.5		6		8		12		7		4.6	
Thermal Conductivity, (Btu/sq ft/ft/hr/deg F at 68F)	19		17		20		27		34		23		17	
Tensile Strength (thousands psi)	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft
Sheet	85	58	100	60	84	55	86	55	85	55	78	55	78	54
Rod	..	..	..	..	..	..	..	..	..	..	..	..	75	54
Tube	..	..	..	..	..	..	..	..	..	..	..	..	80	60
Elongation in 2 in. (%)														
Sheet	3	40	3	40	5	40	5	40	5	60	5	40	5	35
Rod	..	..	..	..	..	..	..	..	..	..	..	..	15	45
Tube	..	..	..	..	..	..	..	..	..	..	..	..	5	45
Yield Strength (0.5% extension, thousands psi)														
Sheet	74	25	85	27	75	20	75	20	68	20	75	18	75	16
Rod	..	..	..	..	..	..	..	..	..	..	..	..	70	18
Tube	..	..	..	..	..	..	..	..	..	..	..	..	..	25
Rockwell Hardness														
Sheet	87B	85F	91B	90F	85B	40B	85B	35B	85B	35B	82B	35B	85B	40B
Rod	..	..	..	..	..	..	..	..	..	..	..	..	80B	35B
Tube	..	..	..	..	..	..	..	..	..	..	..	..	82B	80F

*Gas, carbon arc, metal arc. For thin gages, spot and seam welding.

pleasing color and tarnish resistance make leaded nickel silver suitable for lock washers, cotter pins, fuse clips, etc.

Beryllium Copper: This is the outstanding heat-treatable copper alloy. It responds to a relatively simple precipitation hardening treatment. A common use is for complex springs which could not be formed in the hardened state. Because this alloy has easy formability in the soft condition and a high proportional limit, high fatigue endurance, and great creep resistance in the hardened state, it can be used for springs of this type by hardening after forming. It is also used for hard, corrosion resistant nonmagnetic parts that wear well against hardened steel.

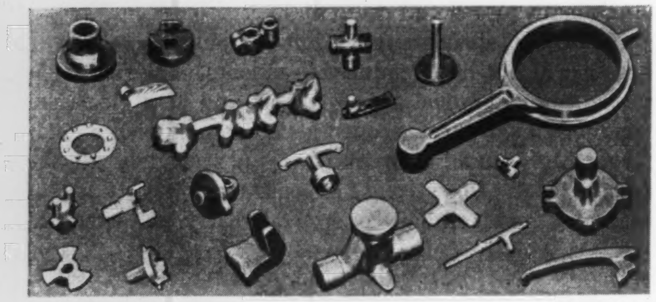
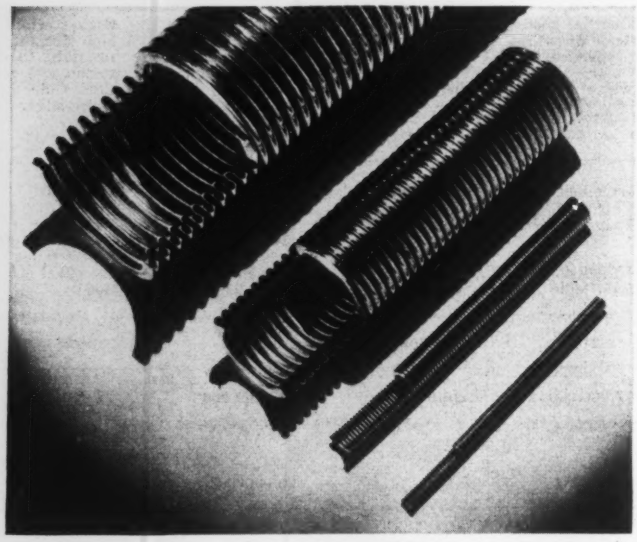


Fig. 7—Above—Representative group of brass, bronze and copper forgings, showing the flexibility in design that may be employed, guaranteeing strong, smooth-finished parts

Fig. 8—Below—Phosphor bronze was selected for these flexible metal hoses because among its qualities are high strength, fatigue resistance, corrosion resistance, ease of welding, and easy workability



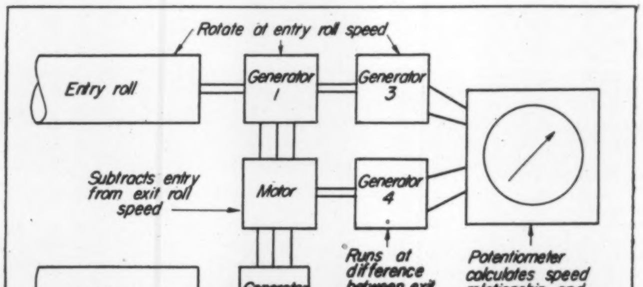
About 20 years ago a compilation was made which showed that there were on the market over 900 different wrought alloys having a copper base. Most of these were closely related to each other metallurgically. The modern trend is to simplify the lists of mixtures, standardizing on a relatively few alloys having distinctly different properties. Engineering advice from the brass supplier operating on this principle usually enables the designer to secure the properties that he wants in these readily available standard mixtures and tempers. When a new alloy is developed nowadays it must fill a real economic need in order to justify its existence. Few, indeed, are the requirements that are not satisfied by a standard alloy manufactured by modern careful mills with scientific quality control.

New Strip-Mill Extensometer Developed

UNIQUE type of continuously indicating and recording extensometer measures extension of strip steel during rolling in temper-pass mills. It was common practice, prior to installation of this instrument, to measure strip extension by a hand operated gage, and such measurements could not be obtained satisfactorily at mill operating speeds in excess of approximately 200 feet per minute. Installation of the equipment, permits extension measurements at operating speeds up to 2000 feet per minute.

The extensometer is designed to indicate and record the percentage of extension being effected on the temper-pass mill by measuring the entry and delivery speeds of the strip, and comparing the differential between the two speeds with the entering strip speed. Entry-delivery strip speed differential is obtained with a system consisting of two synchronous transmitters, one driven by the entry roll and the other driven from the delivery deflector roll. The synchronous transmitters are electrically connected to a synchronous differential receiver, the receiver driving a tachometer generator that generates a voltage proportional to the true differential speed. A second tachometer generator is driven by the entry deflector roll and generates a voltage proportional to the strip entry speed. These two voltages are applied to a self-balancing potentiometer which indicates the ratio of the two voltages. Since this ratio is proportional to the strip extension, the potentiometer is calibrated accordingly.

The illustration shows a schematic arrangement of the apparatus required for a typical temper-pass mill extensometer installation. The equipment, developed by the United States Steel Corp., is designed to operate with an accuracy of approximately 0.04 per cent over a range of 8 to 100 per cent of normal strip operating speed, while measuring extensions varying from 0.1 per cent to 8 per cent.


Rotate at entry roll speed
Entry roll
Generator 1
Generator 3
Subtracts entry from exit roll speed
Motor
Generator 4
Runs at difference between exit and entry speed
Potentiometer calculates speed relationship and indicates percentage reduction on dial
Exit roll
Generator 2
Rotate at exit roll speed

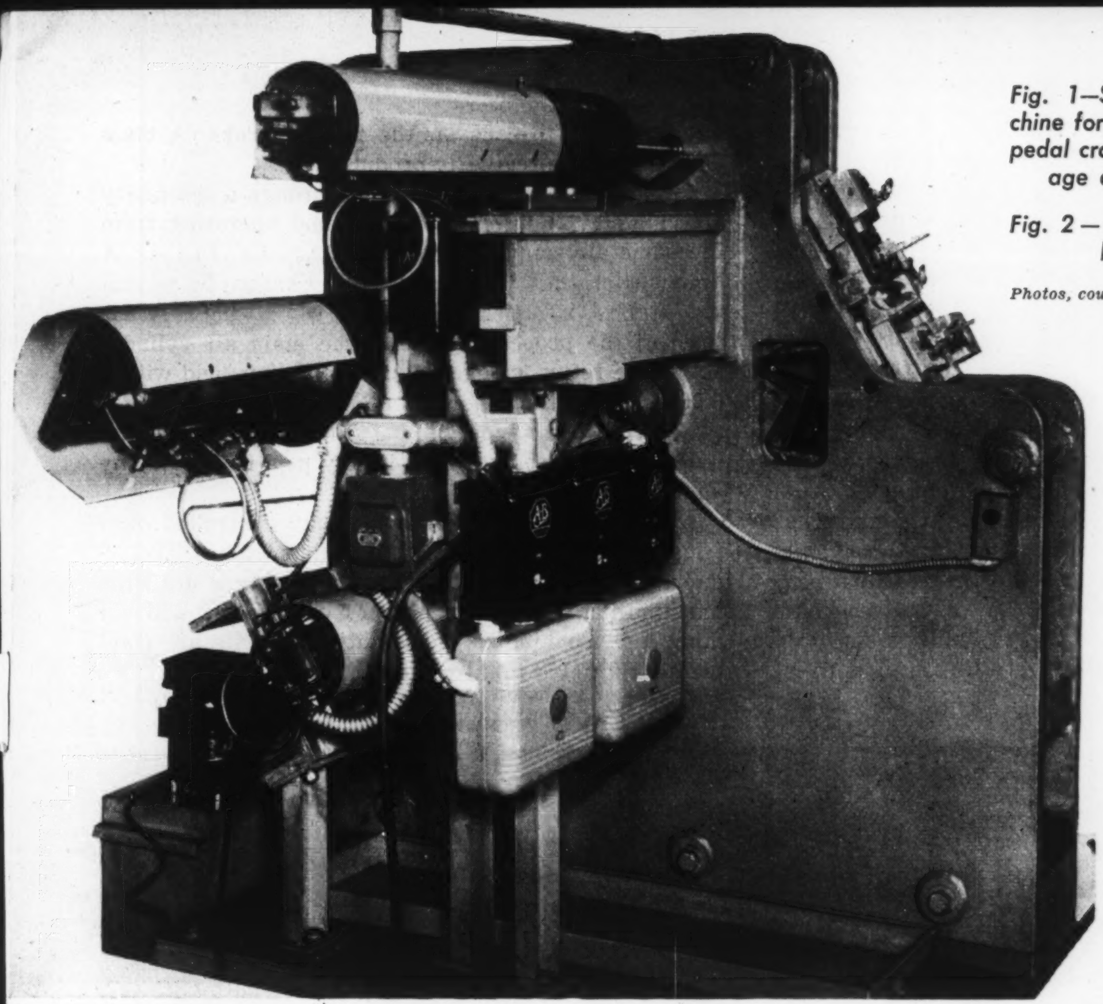
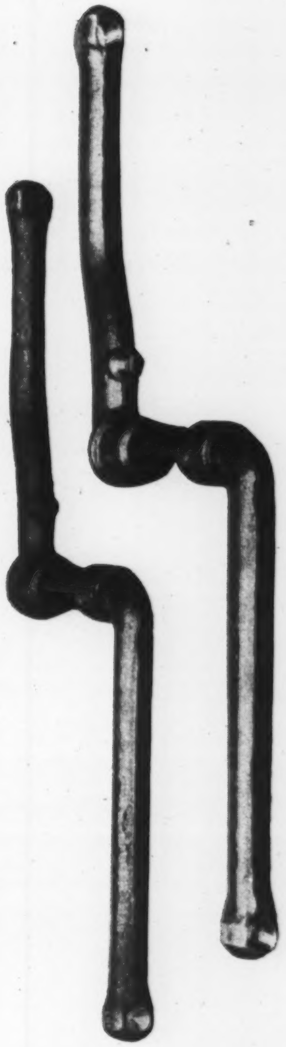


Fig. 1—Semiautomatic indexing machine for drilling and tapping bicycle pedal cranks uses floating-rotor package drilling and tapping units

Fig. 2 — Below — Rough and finished bicycle pedal cranks

Photos, courtesy Barth Stamping & Machine Co.



Floating-Rotor Motor

. . . utilized for spindle advance in package unit

SPECIAL automatic and semiautomatic machines designed around basic "package units" can cut production costs drastically and promote increased uniformity in the finished pieces. The machine shown in ***Fig.*** **1** is an excellent illustration of an arrangement of this type—a semiautomatic unit that performs four operations on a bicycle pedal crank, *Fig.* 2. This machine employs three production drilling units and two tapping units which are operated by air pressure with a hydraulic check for feed control.

Built by the Black Drill Co. with a patented traversing rotor, these unique package units eliminate the customary splined shaft and apply torque directly to the tool mounted on the solid motor shaft, so that lost motion and play is reduced practically to zero, *Fig.* 3. The motor rotor actually shifts in and out of the magnetic field, provision being made in the motor windings to compensate for loss of torque and to dissipate the heat. The units operate in any position or at any angle and the design is flexible so that they are easily modified to incorporate extended shafts and extralong strokes.

A special ¾-hp unit with a 6-inch stroke, operating at 1150 rpm, performs a ⅜-inch diameter hollow milling operation on the driving lug for the sprocket on the pedal crank. This unit required a long stroke in order to clear the frame of the machine—4 inches of nonrotating travel and 2 inches of working travel. Thus, with the standard-length stator the rotor leaves the magnetic field completely on the return stroke. A built-in limit switch automatically turns the motor on and off as the rotor enters and leaves the magnetic field. This is entirely feasible as the rotor attains full speed within 1½ turns.

Two standard ¾-hp units operate at 840 rpm for a combination operation consisting of 7/16-inch tap drilling and ¾-inch diameter spot facing of the bicycle pedal holes. Spot facing is held to close limits through the depth adjustment control on the unit which is capable of repeating within 0.001-inch.

The last operation consists of tapping the two pedal holes ½-20 National threads, one right-hand and one left-hand, with two opposed tapping heads. These are standard tapping units, 540 rpm, built with the same traversing type motor rotor design. The tapper is also operated by air pressure through a double-acting air cylinder controlled by a built-in four-way air valve. Adjustable needle valves control the flow of air so that the tap follows its own lead without chamfering the first threads and does not strip the threads on the return stroke. A class 3 thread can be regularly produced.

Automatic reversal is obtained through a secondary air cylinder, mounted on top of and operating from the same air supply as the main cylinder, *Fig.* 4. A limit switch that operates through a magnetic reversing starter reverses the motor when the tap has reached the proper depth and the main air cylinder starts the return stroke. Depth control is held within 0.001-inch so that there is no danger of tap breakage even when tapping blind holes. These tapping units are designed to work in any position or at any angle.

All five units on this machine are controlled electrically through solenoids and limit switches. Interlocking will not permit any unit to advance until the machine has indexed to proper position and will not allow the machine to index until the units are completely retracted to initial position.

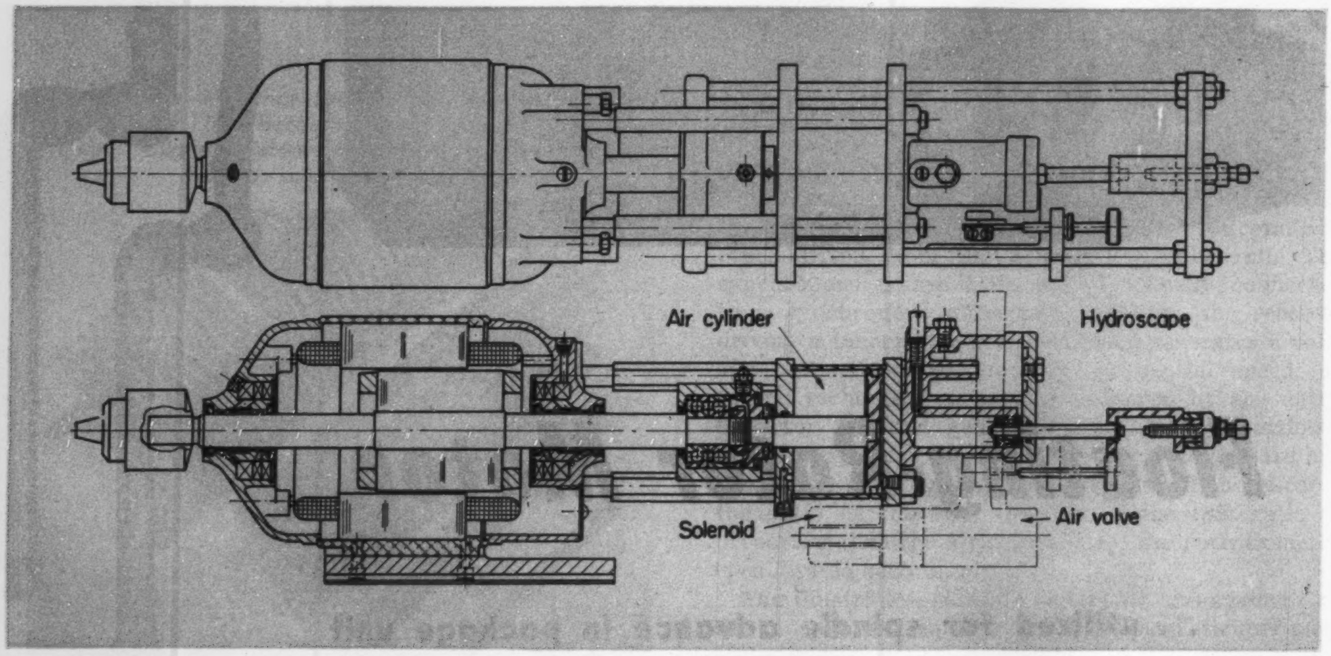
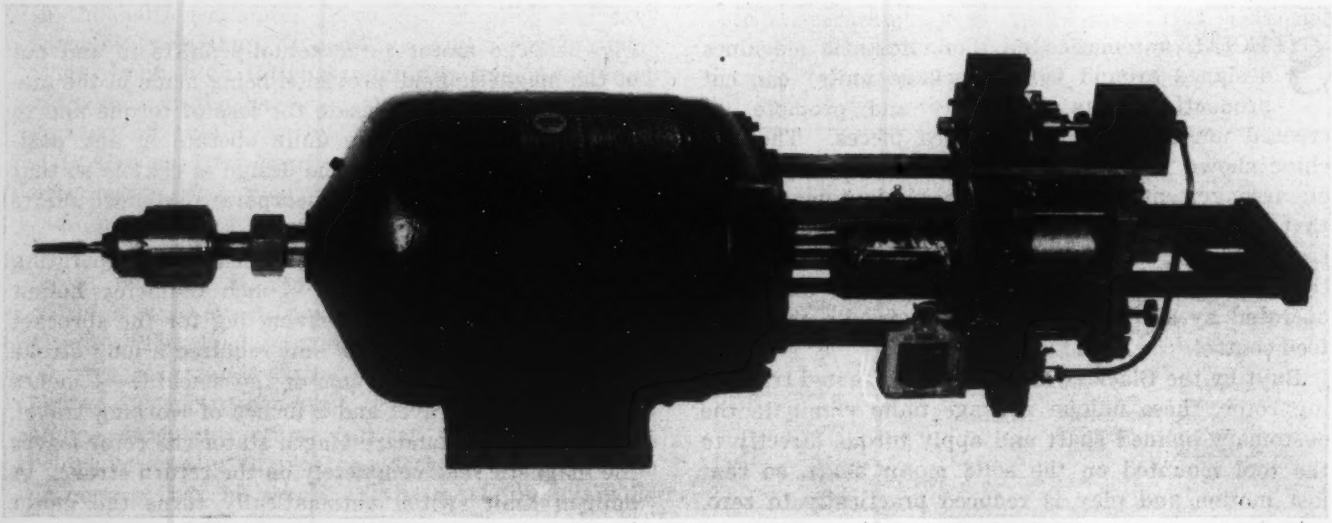


Fig. 3—Above—Cross section of floating rotor drilling unit showing pneumatic actuator and hydraulic feed control

Fig. 4—Below—Automatic tapping head with secondary air control valve and limit switch visible on main cylinder



Relay Circuit Analysis

. . . by "odd-even" algebra

By Edward C. Varnum
Mathematician
Barber-Colman Co.
Rockford, Ill.

A UNIQUE APPROACH to circuit design is presented in this article. Based on a new but easily understood system, the principles outlined have considerable practical value in simplifying circuits as well as in determining their condition for any combination of relay positions

TO DETERMINE whether a complex circuit—electrical or hydraulic—is open or closed has previously required a type of mathematics with which few engineers are familiar. To avoid introducing this higher mathematics, a simple type of mathematics, called *odd-even algebra,* can be used. This algebra differs from conventional algebra in two ways: (1) only whole numbers are used and (2) every even number is considered to be the same as zero while every odd number is considered to be the same as the number 1. This second rule makes several interesting changes in the appearance of the laws, e.g., $1 + 1 = 0$, but they are easily understood.

Basic Vocabulary: In translating from circuits to formulas it is necessary to relate the two possible positions of a switch to the two possible representative numbers and also to give the elementary formulas for series connection and parallel connection. These facts are matters of definition, and are as follows:

1. A closed switch is represented by an odd number
2. An open switch is represented by an even number
3. If X represents one switch and Y represents another, then the system consisting of the two switches in series is represented by XY
4. If X represents one switch and Y represents another, then the system consisting of the two switches in parallel is represented by $X + Y + XY$

The foregoing basic facts are illustrated in *Fig.* 1. For example, if two closed switches are in parallel, the first switch may be represented by 3 and the second by 5. The number for the parallel connection will be $3 + 5 + 15 = 23$. As 23 is an odd number, the parallel circuit is itself closed. In practice, it is convenient to let 1 represent all odd numbers and 0 represent all even numbers, but this is a convenience rather than a necessity.

Laws of Odd-even Algebra: The multiplication table for odd-even algebra consists of only four products which agree with the customary algebraic laws:

$0 \times 1 = 0$; an even number times an odd number is an even number

$1 \times 0 = 0$; an odd number times an even number is an even number

$0 \times 0 = 0$; an even number times an even number is an even number

$1 \times 1 = 1$; an odd number times an odd number is an odd number

The addition table also has four elements. The first three are identical with ordinary addition. The fourth law of addition appears different because 2,

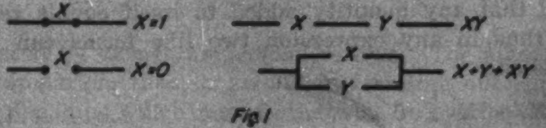


Fig 1

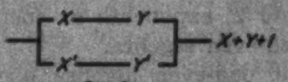


Fig 2

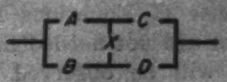


Fig 3

Fig. 1—Closed switch is represented by odd number (1) and open switch by even number (0) as shown at left. Series and parallel circuits and their representation are shown at right

Fig. 2—Three-way switch circuit, such as is used for two-station light control, has two complementary switches. When X is open X' is closed, and vice versa. Complete circuit is represented by X + Y + 1 from which it is seen that a change in either X or Y changes the entire circuit

Fig. 3—Simple bridge circuit with relays A, B, C, and D. Formula for circuit is given in Equation 10

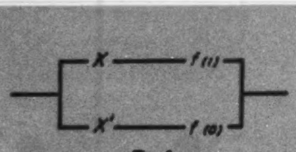


Fig 4

Fig. 4 — Circuit represented by Theorem 1 in the article

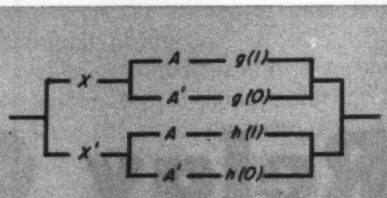


Fig. 5

Fig. 5—Circuit for the expansion about two switches

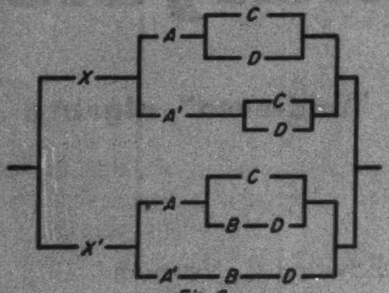


Fig 6

Fig. 6—Successive expansion of circuit such as shown in Fig. 5

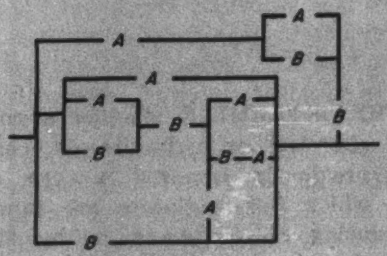


Fig.7

Fig. 7—Circuit made up of several positions of switches A and B, which is equivalent to A in parallel with B

being an even number in conventional algebra, becomes identified as 0 in odd-even algebra:

$0 + 1 = 1$; an odd number added to an even number is an odd number

$1 + 0 = 1$; an even number added to an odd number is an odd number

$0 + 0 = 0$; an even number added to an even number is an even number

$1 + 1 = 0$; an odd number added to an odd number is an even number

From the last two laws of multiplication, it will be observed that any power of a quantity is identical with the quantity:

$$X^n = X \qquad (1)$$

where n is a positive integer.

From the last two laws of addition, it should be noted that any quantity added to itself equals zero and thus in any expression two like terms can be cancelled:

$$X + X = 0 \qquad (2)$$

Because of Equations 1 and 2, exponents or coefficients are not needed in odd-even algebra.

It will be observed that odd-even algebra obeys the laws of ordinary algebra if we withhold the identification of even numbers with zero and odd numbers with unity until the very end of the calculations, which is permissible. The only necessary change in thinking is the concept of identifying a whole class of numbers with a single number.

COMPLEMENTARY SWITCHES: Two switches are complementary if one is always in the opposite position from the other. Designating the complement of X by X', X is open when X' is closed and X is closed when X' is open. The formula for X' is:

$$X' = X + 1 \qquad (3)$$

The three-way switch circuit is in effect two complementary switches, the circuit employing two three-way switches being shown in *Fig.* 2. The formula for this circuit is derived as follows: The formula for the upper branch is XY. The formula for the lower branch is $(X + 1)(Y + 1) = XY + X + Y + 1$. Combining these two formulas by use of definition 4 under Basic Vocabulary, the formula for the circuit is:

$$XY + (XY + X + Y + 1) + XY(XY + X + Y + 1)$$

Removing parentheses:

$$XY + XY + X + Y + 1 + X^2Y^2 + X^2Y + XY^2 + XY$$

Applying Equation 1,

$$XY + XY + X + Y + 1 + XY + XY + XY + XY$$

and applying Equation 2, $XY + XY = 0$, therefore the formula for the circuit is

$$X + Y + 1 \qquad (4)$$

It will be noted from Equation 4 that a change of either X or Y will change the entire circuit. This is the property for which the circuit is designed.

FUNCTION THEOREMS IN ODD-EVEN ALGEBRA: A function of X is an algebraic expression containing the letter X. Even if the expression contains other letters, it can be considered as a function of X. Thus, for example, the expression $X + Y + XY + 1$ is a function of X, which is written

$$f(X) = X + Y + XY + 1$$

If this is the function of X that is meant, then by $f(0)$ is meant the result found by letting $X = 0$ in $f(X)$, thus:

$$f(0) = 0 + Y + 0 \times Y + 1 = Y + 1$$

Similarly, $f(1)$ is found by letting $X = 1$ in $f(X)$:

$$f(1) = 1 + Y + 1 \times Y + 1 = 0$$

where the reduction to 0 has been accomplished by noting that $1 + 1 = 0$ and $Y + Y = 0$. The three foregoing equations are simply examples to illustrate the function idea and are not to be taken too seriously; thus, $f(1)$ does not always equal 0, because $f(X)$ is not always $X + Y + XY + 1$.

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Any function of X in odd-even algebra can be expanded by the following theorem:

Theorem 1: $f(X) = Xf(1) + (X + 1)\, f(0)$

This expansion theorem is verified by substitution of the only two possible values of X, viz. 0 and 1:

$$f(0) = 0 \times f(1) + (0 + 1)\, f(0) \quad \ldots\ldots\ldots (5)$$

$$f(1) = 1 \times f(1) + (1 + 1)\, f(0) \quad \ldots\ldots\ldots (6)$$

Using the laws of multiplication and addition, i.e., zero times any quantity is zero, one times any quantity is the quantity itself, zero added to any quantity is the quantity itself, and the sum of two like quantities is zero, the truth of Equations 5 and 6 is shown.

By multiplying both members of Theorem 1 by X and noting that $X^2 = X$ and that $X(X + 1) = X^2 + X = X + X = 0$ the following theorem may be derived:

Theorem 2: $Xf(X) = Xf(1)$

An inspection of Theorem 2 might tempt one to divide both members by X and thus conclude that all switches are closed. However, the fact that some switches are open, $(X = 0)$ prohibits division by X because, as in ordinary algebra, division by zero is to be avoided. Inasmuch as X has a good chance of being zero, division by X is to be avoided.

APPLICATION OF FUNCTION THEOREMS: The expansion theorem may be applied to circuit analysis as follows: Assume a circuit resembling the customary bridge circuit, as shown in *Fig.* 3. Let the formula for the circuit be $f(X)$. By considering X closed, there results a circuit in which A and B in parallel are in series with C and D in parallel, so that by definitions 3 and 4 under Basic Vocabulary:

$$f(1) = (A + B + AB)\,(C + D + CD) \quad \ldots\ldots (7)$$

By considering X open, A and C in series are in parallel with B and D in series, so that

$$f(0) = AC + BD + ABCD \quad \ldots\ldots\ldots\ldots\ldots (8)$$

Putting Equations 7 and 8 into *Theorem* 1 the formula for the circuit is

$$f(X) = X(A + B + AB)\,(C + D + CD) + (X + 1)\,(AC + BD + ABCD) \quad \ldots\ldots\ldots (9)$$

After expanding and cancelling, the formula for the circuit can be written

$$BCX + ABCX + ADX + ABDX + ACDX + BCDX + AC + BD + ABCD \quad \ldots\ldots\ldots (10)$$

By successive application of the expansion theorem, the formula for any circuit can be found by considering one switch at a time.

Theorem 2 has a circuit interpretation by noting that if a switch X is in series with a circuit which contains other switches X, then the openness or closure of the entire system is unchanged by permanently closing all switches X except the original one. The truth of the foregoing is apparent when it is realized that if X is open the entire circuit is open and if X is closed, the permanently closed X switches agree with the "outside" X. Having discovered a circuit fact by algebraic manipulation, its validity can be seen by elementary considerations. The algebraic manipulation, then, is an aid in ferreting out simple relationships which might otherwise be overlooked.

Table 1. Circuits Using Two Relays

Circuit*	Formula	Condition of Circuit with			
		Y on Z on	Y on Z off	Y off Z on	Y off Z off
—— ——	0	Off	Off	Off	Off
—Y'——Z'—	$1 + Y + Z + YZ$	Off	Off	Off	On
—Y'——Z—	$Z + YZ$	Off	Off	On	Off
——Y'——	$1 + Y$	Off	Off	On	On
—Y——Z'—	$Y + YZ$	Off	On	Off	Off
——Z'——	$1 + Z$	Off	On	Off	On
Y——Z' Y'——Z	$Y + Z$	Off	On	On	Off
Y' Z'	$1 + YZ$	Off	On	On	On
—Y——Z—	YZ	On	Off	Off	Off
Y——Z Y'——Z'	$1 + Y + Z$	On	Off	Off	On
——Z——	Z	On	Off	On	Off
Y' Z	$1 + Y + YZ$	On	Off	On	On
——Y——	Y	On	On	Off	Off
Y Z'	$1 + Z + YZ$	On	On	Off	On
Y Z	$Y + Z + YZ$	On	On	On	Off
————	1	On	On	On	On

* The prime (') denotes a complementary switch which is open when its complement is closed and closed when its complement is open. Thus Y' is open when Y is closed, and vice versa.

Example: The notation being $1 = \text{On}$ and $0 = \text{Off}$, the circuit for which the formula is $Y + YZ$ is On because $1 + 1 \times 0 = 1$ when $Y = 1$ (On) and $Z = 0$ (Off).

DERIVING A CIRCUIT FROM A GIVEN FORMULA: The final step in applying mathematical methods is to translate the symbolic result back into the physical system. In order to derive a circuit for a given formula, note that the formula in Theorem 1 is given by the circuit in *Fig.* 4, because the formula for *Fig.* 4 is obtained by applying definitions 3 and 4 under Basic Vocabulary:

$$X \times f(1) + (X + 1)\, f(0) + X \times f(1) \times (X + 1)\, f(0) \quad \ldots\ldots\ldots (11)$$

$$X \times f(1) + (X + 1)\, f(0) + Xf(1) \times f(0) + Xf(1)f(0) \quad \ldots\ldots\ldots (12)$$

$$Xf(1) + (X + 1)f(0) \quad \ldots\ldots\ldots (13)$$

For any given formula the foregoing process can be applied successively for each switch by calculating $f(1)$ and $f(0)$ and substituting into the circuit of *Fig.* 4.

As an example, consider the formula $X + Y + 1$

(*Continued on Page* 192)

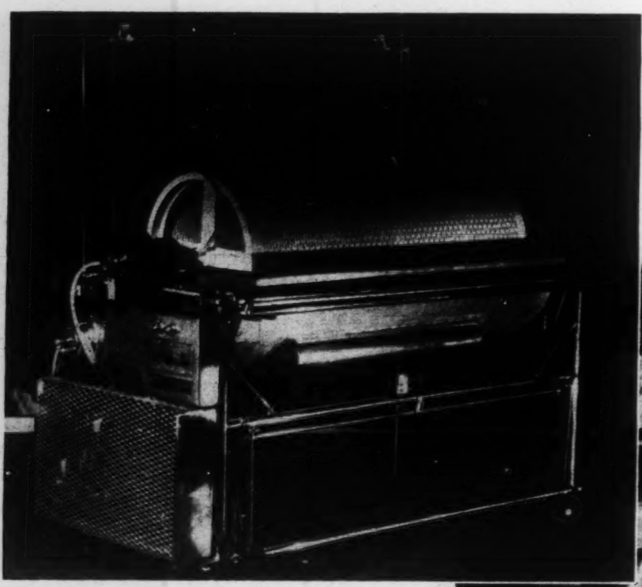


Fig. 1—Left—Mechanical kidney replaces functions of human kidney where acute uremic poisoning exists

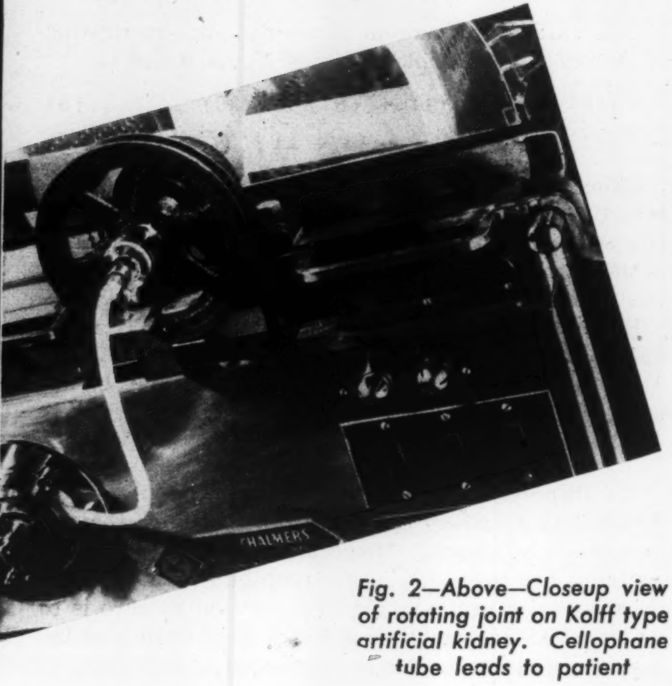


Fig. 2—Above—Closeup view of rotating joint on Kolff type artificial kidney. Cellophane tube leads to patient

Mechanical Kidney Developed

BUILT of stainless steel, the mechanical counterpart of the human kidney shown in *Fig.* 1 was recently developed and built by Allis-Chalmers Mfg. Co. Of the type invented in 1944 by Dr. W. J. Kolff of Holland, it is about 51½ inches long, 42 inches high and 24 inches wide. It consists of a perforated drum which rotates at 18 rpm partially submerged in a bath of rinsing fluid containing primarily electrolytic salts. Both drum and bath are constructed of aluminum covered with a type of Vinylite. The unit is powered by a ¼-hp single-phase motor.

The drum is spiralled by about 140 feet of cellophane tubing through which the blood flows as the drum rotates. This tubing is actually sausage casing which permits certain sized molecules to flow through its walls. As the blood travels through the tubing, passing along always below the level of the bath water, the poisons, due to their molecular size, seep through the tubing walls into the rinsing fluid. The fluid must be changed every two hours to keep its poison concentration below that of the blood. Seepage of poison through the cellophane tubing from high to low concentration cleanses the blood.

Interesting features of the new unit include a safety device for by-passing the blood in the event the cellophane tubing tears, a clutch appliance which permits the drum reel and pump to run separately, ± one degree thermostatic control of the bath, a plastic cover for maintaining even temperature, and a hypodermic syringe which provides a rotating or slip-ring type of joint.

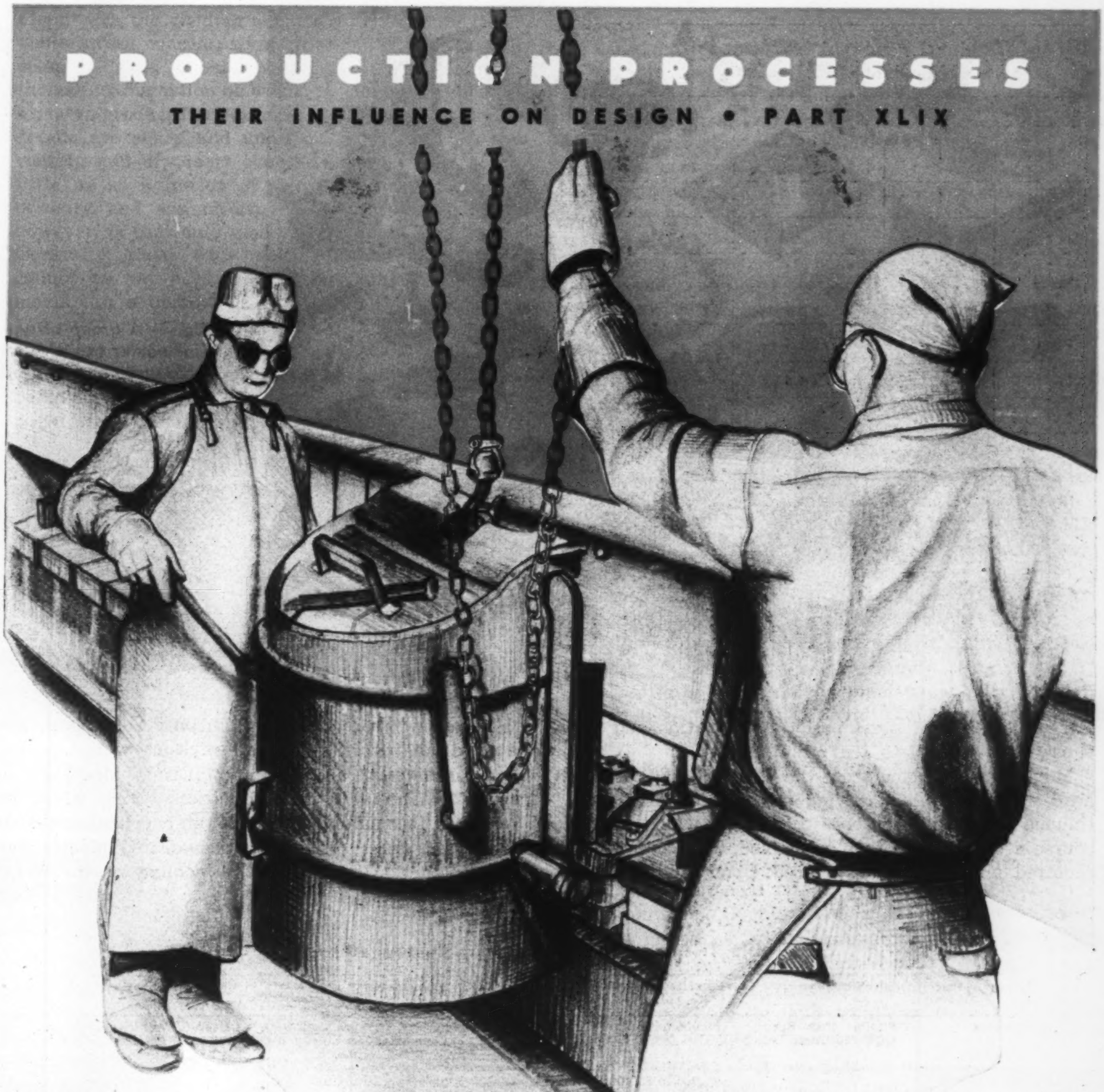
To form the rotating joint, *Fig.* 2, the ends of a hollow plunger in a hypodermic syringe were cut off, making the plunger a tube and the stationary member of the joint. This joint is fastened to the tube which leads to the patient. The body of the syringe rotates with the drum and is connected to the cellophane to provide an effective nonmetallic seal for the two rotating joints.

Two pumping actions are provided by the machine: one a pressure produced as the blood is worked along the bottom sections of the spiral winding by the drum's rotation; the other a milking action of a Beck type pump which returns the blood to the level of the patient. This latter action is accomplished by three cylinders mounted on a rotating unit which squeeze the tubing within the pump housing and at the same time roll the blood ahead of it. Capacity of the pump varies to 250 cc per minute depending upon the application. It changes the blood in the kidney completely about every two minutes.

While the blood flows through the mechanical unit, which is held within one degree of body temperature, it is kept from clotting by heparin. Allis-Chalmers engineers under the direction of Jack Wilson, chief physicist, and George Cassel of the firm's new product development department, handled the work on the kidney.

PRODUCTION PROCESSES

THEIR INFLUENCE ON DESIGN • PART XLIX



Plaster-Mold Casting

By ROGER W. BOLZ, *Associate Editor, Machine Design*

SIMILAR in many general aspects to permanent-mold casting, the plaster-mold process represents a further step in the search for the ideal mold medium. Used many centuries ago in fine arts for producing bronze statuary, plaster as a mold material for the production of castings on a commercial scale has only recently come into use. Developed largely during the past fifteen years, plaster-mold castings, *Fig.* 1, are now produced regularly in production quantities by four or more slightly differing techniques.

PLASTER-MOLD PROCESS: In general, the various methods of plaster-mold casting are similar. The plaster, also known as gypsum or calcium sulphate, is mixed dry with other elements such as talc, sand, asbestos, and sodium silicate. To this mix is added a controlled amount of water to provide the desired permeability in the mold. The slurry which results is heated and delivered through a hose to the flasks, all surfaces of which have been sprayed with a parting compound. The plaster slurry readily fills in and around the most minute details in the highly polished brass patterns. Following filling, the molds

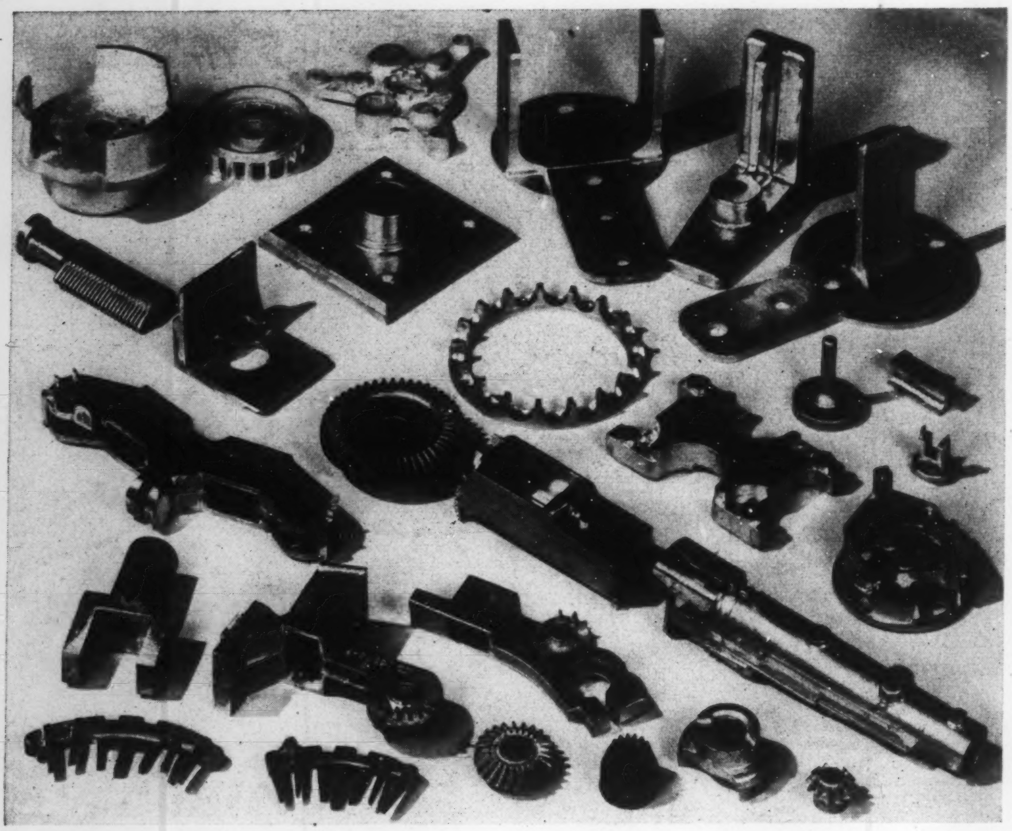


Fig. 1—A group of typical nonferrous plaster-mold castings produced in quantity

are subjected to a short period of vibration and the slurry sets in five to ten minutes.

Molds are extracted from the flask with a vacuum head, following which drying is completed in a continuous oven, *Fig.* 2. Copes and drags which are of course necessary, are then assembled, with cores when required, and the castings poured. Upon solidification, the plaster is broken away and any cores used are washed out with a jet of high-pressure water.

Advantages: The most outstanding advantage in use of plaster as a mold material, is that it can be varied in thermal capacity from an excellent insulator to a mild chill. Completely dehydrated plaster has no chill action and thus slow cooling of the metal

Table 1—Standard Plaster-Mold Casting Alloys

Alloy	Specifications	Tensile Strength (psi)	Hardness (Rockwell)	Characteristics	Applications
Yellow Brass No. 10	Similar Fed. Spec. QQB-726-Class D	55,000 to 70,000	55 to 75 B	High-strength brass, lowest in cost, good machining, high fatigue resistance.	Used for brackets, brush holders, frames, retainers, gears, levers, hardware.
Aluminum Bronze No. 20		75,000 to 85,000	56 to 80 G	High-strength, lighter than steel or other copper-base alloys, high wear and corrosion resistance.	Used for gears, sprockets, bearings, marine parts, dies, pump parts, universal joints.
Manganese Bronze No. 70	Fed. Spec. QQB-726-Class A Navy Spec. 49-B-3	65,000 to 80,000	60 to 80 B	High-strength bronze, good corrosion resistance, good ductility.	Used for levers, fasteners, valve bodies, gears and marine parts.
Manganese Bronze No. 100	Similar Navy Spec. 46-B-29 Class B	100,000 to 115,000	60 to 85 G	Super strength bronze, no heat treatment necessary, good ductility, good corrosion resistance.	Similar uses to No. 70 bronze where superior physical properties are desired.
Silicon-Aluminum-Bronze		59,000	65 to 75 B	High copper-silicon alloy, excellent corrosion resistance and wearing qualities.	For outdoor applications, electrical parts, connectors, hardware, etc.
Nickel Brass (15 and 22% nickel)		50,000	80 to 90 B	Good ductility and corrosion resistance, white satin finish.	Used for corrosion resistant parts, dairy and food processing machinery parts, lock parts, 22% nickel largely used in dairy & food equipment.
Aluminum Alloy No. 60	Alcoa No. 355 SAE No. 322	16,000 to 21,000 (as cast)	....	Casts in thin sections, no skin hardness, good for plating, can be age hardened to 34,000 psi.	Used for instrument and similar parts where highest strength is not required.
Aluminum Alloy No. 375	(Universal)	....	....	High-strength alloy specially developed for plaster-mold casting, superior castability and physicals, good wear resistance.	Used where high strength and corrosion resistance is desired, for aircraft fittings, instrument parts, pump parts, pistons, cylinder heads, etc.

along with the yielding character of the material prevents stress concentrations that might otherwise develop. Plaster molds permit accurate control of shrinkage, distortion or warpage being negligible. The surfaces produced are extremely smooth and the finest details are sharp and undistorted, *Fig.* 1. The self-venting and dry inert character of the mold creates little or no agitation of the metal, eliminating gas porosity and nonuniform density. Major limitation, however, is that only nonferrous metals may be cast. Generally, those with melting points over 1900 F cannot as yet be cast; the maximum temperature molds can withstand is about 2200 F. Experiments, however, are being carried on to adapt the process for other metals and in some cases bronze alloys with melting points as high as 2400 F have been successfully handled.

Patterns: Tooling cost or pattern cost is relatively low. The average pattern generally costs approximately $150 to $200. As the patterns are subjected only to the soft plaster being run over them, there is little abrasion, pressure or shock and consequently pattern life is practically unlimited. As changes are desired, it is usually possible to alter original patterns at low cost.

Patterns are made in split style, for cope and drag molds, and are mounted on precision machined unit strips in a standard flask, *Fig.* 3. Thus, numerous separate patterns can be arranged for casting simultaneously, reducing cost to a minimum. The patterns are accurately constructed and finished. Made from engraver's brass, patterns are held within a maximum variation of plus or minus 0.003-inch and are given a high polish. Because the plaster mold must be easily removable from the flask, pattern design must follow that found desirable for any casting method.

Size of Parts: Size of castings produced is of considerable importance owing to the need for a standardized production line. The standard flask size is 12 by 18 by 3½ to 4-inches in overall depth. This size is most common and permits the casting of parts singly or in multiple from the smallest desired to the largest single piece which can be molded allowing a reasonable margin of plaster over the pattern. Straight partings are preferable and the maximum depth of pattern from the center parting line is 1½ inches or a total, for a symmetrical part, of about 3 inches. Total depth may also depend upon the parting line. Where nonsymmetrical parts with other than a straight center parting are necessary, the greatest depth from one side only of the parting line is 2 inches. Parts weighing up to 15 pounds have been produced in these standard molds.

Parts too large for a standard mold are handled in oversize molds on a special semiautomatic production line. Oversize flasks used in present operations have been standardized as 10 by 18 by 2½ inches, 12 by 21 by 6 inches, and 24 by 36 by 12 inches. In special operations, machine parts up to 35 inches in diameter and weighing over 200 pounds have been successfully cast.

Production: Use of plaster-mold castings is relatively unlimited by quantity requirements. Volumes running from a few hundred pieces per year to

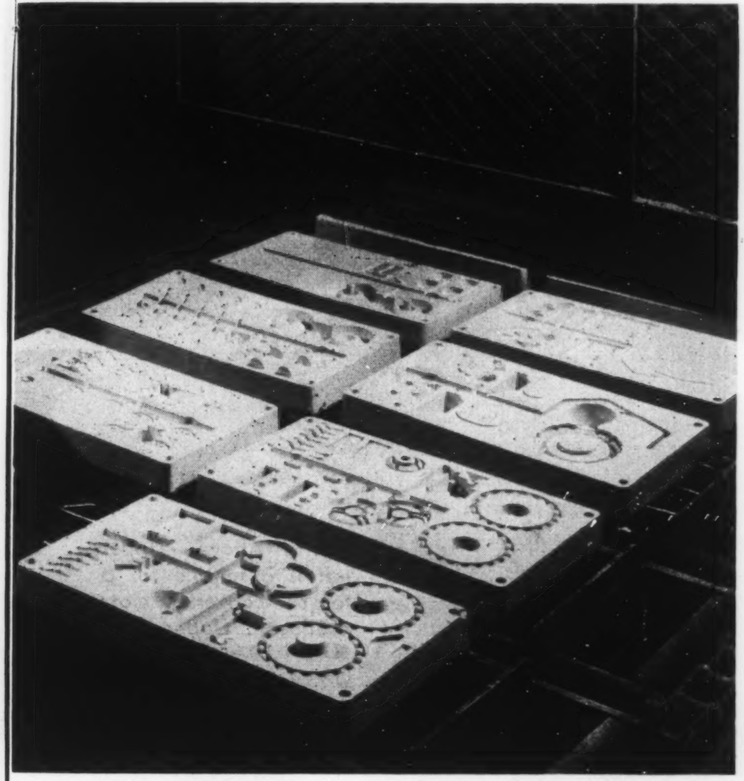


Fig. 2—Above—Finished plaster molds emerging from the continuous drying oven

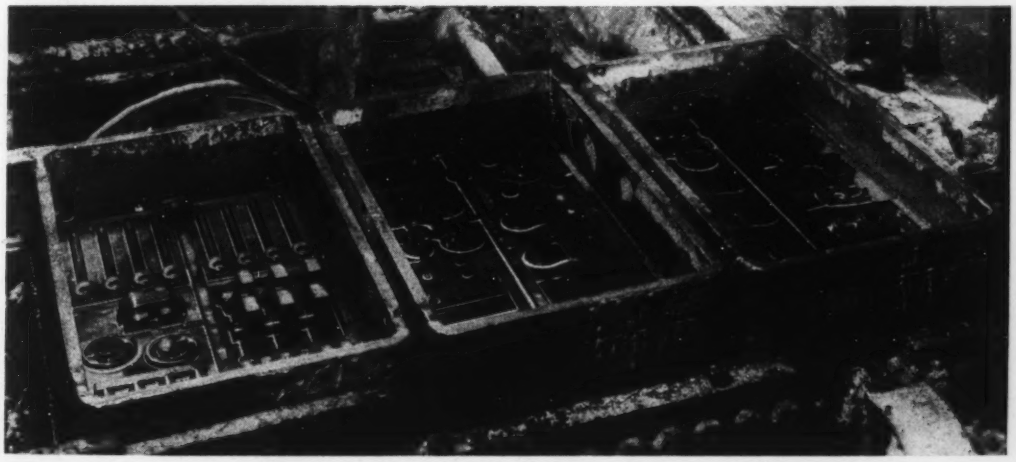


Fig. 3—Right—Flasks on the production line showing various patterns assembled into each for economical runs in the same metal

several million pieces can be produced equally well. The unit strip flask system and standardized metals make small runs and even single parts for experiment feasible. Depending upon the design complexity, production per pattern per week on the unit strip plan runs about 150 to 250 pieces and with full plate of patterns this is increased to 300 to 450 pieces per pattern per week.

DESIGN CONSIDERATIONS: Most important feature of the plaster-mold casting process is the practicability of producing parts to exacting dimensions so that machining, finishing, balancing, etc., are almost totally eliminated, *Fig.* 4. Parts having internal splines, ratchet teeth, stops, blind gear teeth, airfoil-section blades, integral rivets, etc., which are ordinarily difficult and expensive to machine, can be readily produced, *Fig.* 5. Gears may be cast to regular machining accuracy so as to necessitate only a boring operation.

Draft: As with most casting methods, draft is required but with plaster-mold casting it is needed in order to facilitate withdrawal of the plaster mold from the patterns. Outside surfaces usually require a ½-degree draft angle and inside surfaces, ½ to 3 degrees. Holes or cavities formed by loose cores require no draft but integral core sections do.

Cores: Several pieces can be consolidated into one part by means of separate core pieces but never by loose pieces on the pattern. Undercuts and intricate passages are readily produced, *Fig.* 6. Holes under ½-inch diameter normally can be drilled more economically than cored, *Fig* 7. Drill spots, however, can be placed on the pattern to eliminate fixtures.

Wall Thickness: Plaster, being a poor conductor of heat, is ideal for producing thin, sound walls. Where the area does not exceed 2 square inches, a wall of 0.040-inch can be cast. For larger areas the practical minimum wall thickness increases, for 4 to 6 square inches a thickness of 0.062-inch being minimum and for areas up to 30 square inches the minimum is generally set at 0.093-inch. Tapering sections are readily producible and blade sections can be cast with knife-sharp edges.

Stock Allowances: Round, square or odd-shape holes may be cast with only a minimum of stock machining. Ordinarily where machining is required for any reason, 1/32-inch metal allowance is sufficient but less can be allowed on small parts and cored holes, especially where broaching is to be used.

Markings and Inserts: Markings of almost any nature can be clearly reproduced. Lettering may be

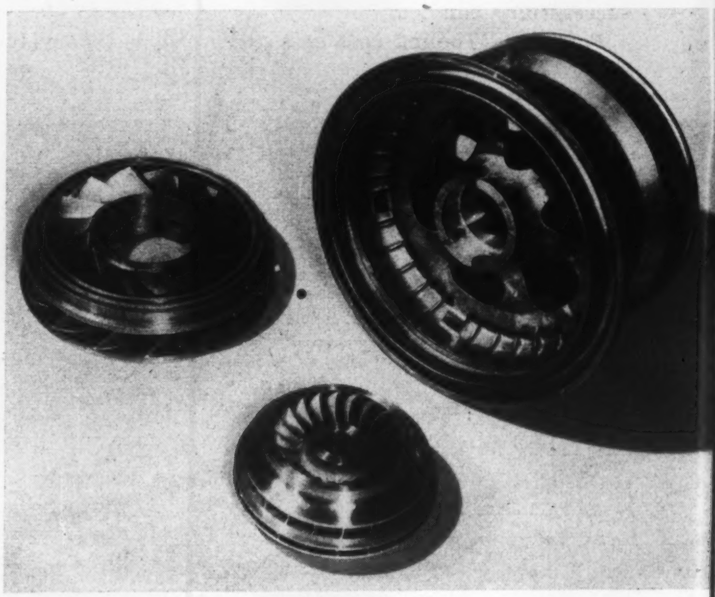


Fig. 4—Above — Upper left is a turbine for a torque converter mass produced. Upper right is a 10-inch aircraft wheel in which a metal saving of two pounds was made. Lower part is a 6-inch, 2-stage shrouded impeller which required critical balance accuracy for operation at 1500 fps peripheral speed and smooth internal surfaces. Vanes of impeller are held within 0.005-inch

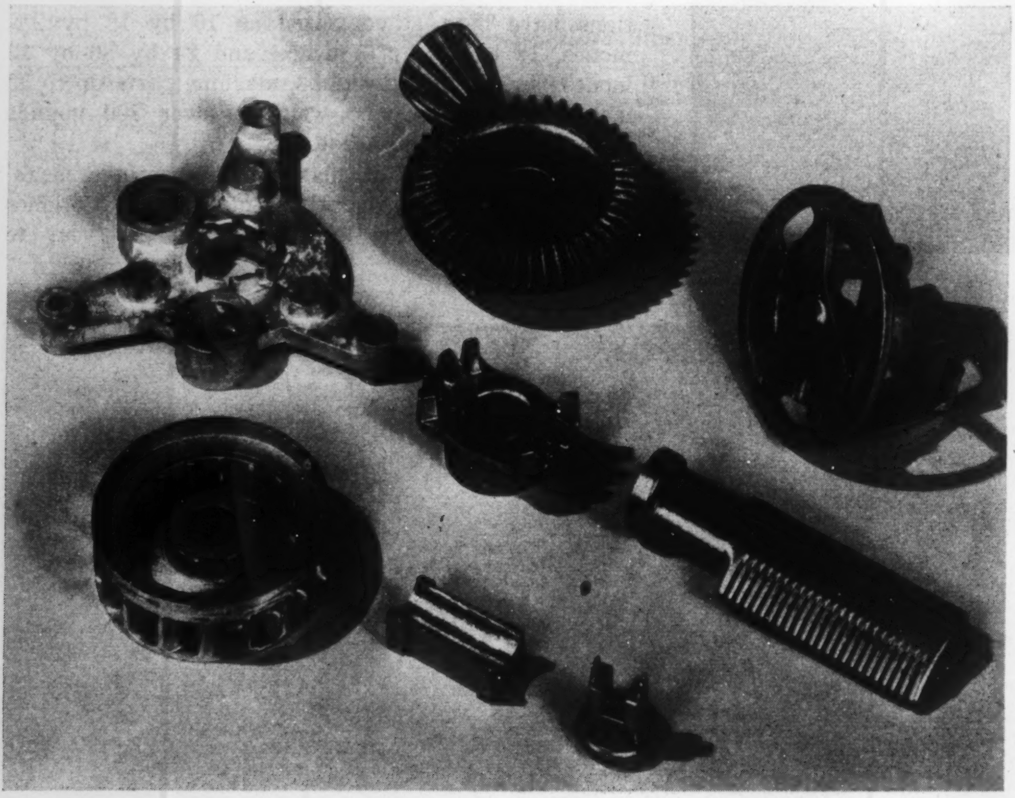


Fig. 5—Left — Group of machine parts showing gear teeth, slots, vanes, ratchets, and cams

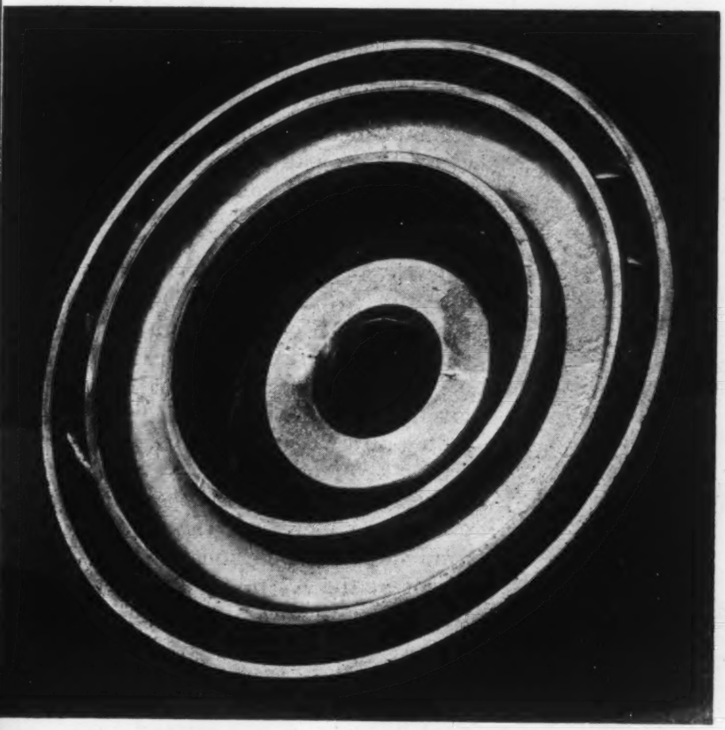


Fig. 6—Cast aluminum runner for automotive torque converter with intricate passages and sharp-edge blades

either raised or depressed as desired, *Fig.* 8. Additional features such as steel or other inserts may be cast-in with the usual considerations for galvanic action and sufficient strength to resist cracking of the casting on cooling.

MATERIALS: To effect maximum economy and satisfactory castings, metals suitable for plaster-mold casting have been developed and standardized. Lower scrap and efficient grouping of production patterns is effected by specifying one of the standard alloys. These alloys and their salient characteristics are given in TABLE 1.

In addition to these standard alloys almost any other castable metal in the nonferrous group can be cast if necessary, although at higher cost. Pure copper can be cast and beryllium-copper alloys produce excellent castings which have high physical properties and which will harden without warpage or relative dimensional change. Others possible include silicon-bronzes, nickel bronzes, nickel-copper, tin bronzes, and silicon-aluminum-bronze.

TOLERANCES: In general, a tolerance of plus or minus 0.005-inch per inch of dimension can be held. Where the dimension crosses the parting line the tolerance is increased to plus or minus 0.010-inch per inch. In specific portions of a casting, however, more exacting tolerances are practical. For instance, overall tolerances of plus or minus 0.005-inch for portions within one half of a mold and plus or minus 0.010-inch where the dimension crosses the parting line are being commercially produced today.

Cored dimensions within a casting can also be held to plus or minus 0.005-inch per inch. Center-to-center dimensions of holes produced by separate cores can be held to the same limits. Tolerances on integral-core portions must take into consideration the draft angle which is required.

Flatness of surface which can be obtained depends to some extent upon the casting design. As a rule, areas of roughly one square inch are readily held flat within 0.005-inch. Larger surfaces, say approximately six square inches, may sustain a warpage ranging from 0.007 to 0.015-inch depending upon design.

Surface roughness in production can be consistently held to 30 microinches, rms, or better. The velvet-smooth surfaces produced are eminently suited for any parts which are to be electroplated.

Collaboration of the following organizations in the preparation of this article is acknowledged with much appreciation:

Atlantic Casting & Engineering Corp.	Clifton, N. J.
Beryllium Corp. of Pa.	Reading, Pa.
Eclipse-Pioneer Div., Bendix Aviation Corp. (Fig. 4)	Teterboro, N. J.
Universal Castings Corp. (Figs. 1, 2, 3, 5, 6, 7, and 8)	Chicago, Ill.

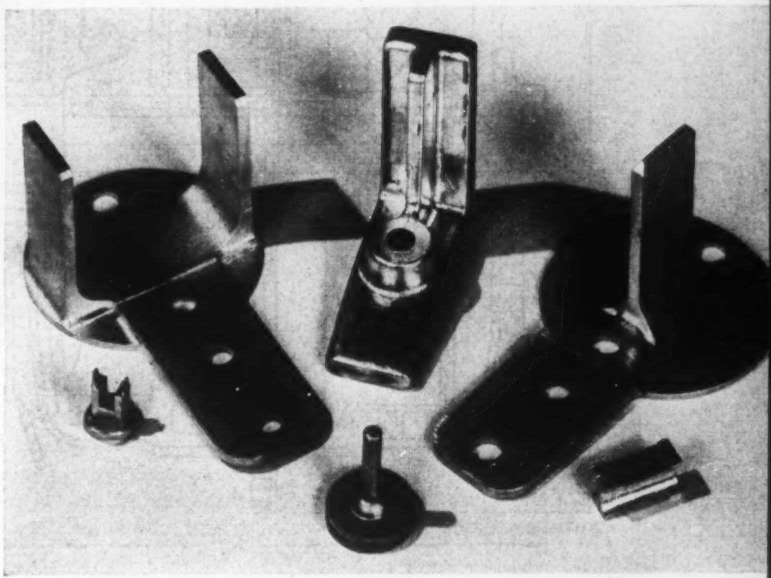
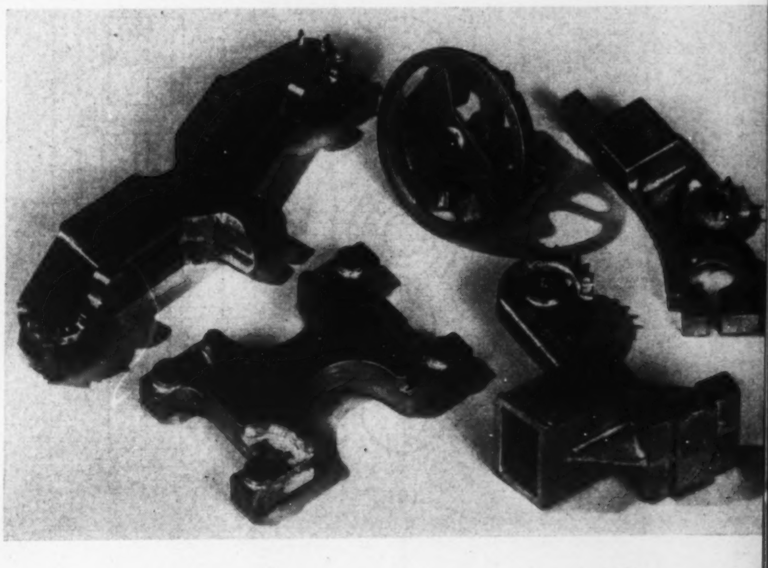


Fig. 7—Above—Several parts of odd shape in which the holes have been cored

Fig. 8—Below—Machine parts on which identifying markings can be seen. Depressed lettering is most economical owing to ease in stamping markings into brass patterns



Centrifugally Controlled Drive

. . . for motor-bike transmission

STEPLESS speed variation in an automatic, two-speed transmission for motor-bikes, or other similar applications, is accomplished in a compact unit using three sets of spool gears and three small cone brakes in conjunction with a centrifugal clutch. Shifting from a 1.7 to 1 low-gear ratio to the 1 to 1 direct-drive ratio is obtained automatically as the speed of the motor-bike increases. Operation of the transmission is as follows: Engine input is to a drive pulley direct connected to a centrifugal clutch which slips under engine idling conditions. As engine speed increases, the clutch gradually engages and delivers power at the 1.7 to 1 gear ratio through the three spool gear sets to the output drive shaft.

When the engine speed reaches a preset limit, centrifugal weights in a governor on the input side of the transmission rotate a cam to engage a brake disk with the three braking cones. Since these braking cones are mounted on the ends of the three spool gear shafts, stopping of the rotation of the spool gears gradually increases the gear speed ratio from 1.7 to 1 to that of direct-drive.

The drawing of the transmission, *Fig.* 1, shows the unit in the high gear or direct-drive position. Governor weights are fully extended, the cone brakes are completely locked and the spool gears are not increasing torque. *Fig.* 2 shows the governor weights in extended (solid lines) and retracted (dotted lines) positions at *a*. Cone brakes are shown in the locked condition, as in direct drive, at *b*, and in *c* the weights are in the collapsed position with the cone brakes unlocked and spool gears free to rotate, as in the low-speed condition. The transmission, manufactured by Powermatic Inc., Akron, O., results in a torque increase of approximately 70 per cent in going from the high to low-gear ratios.

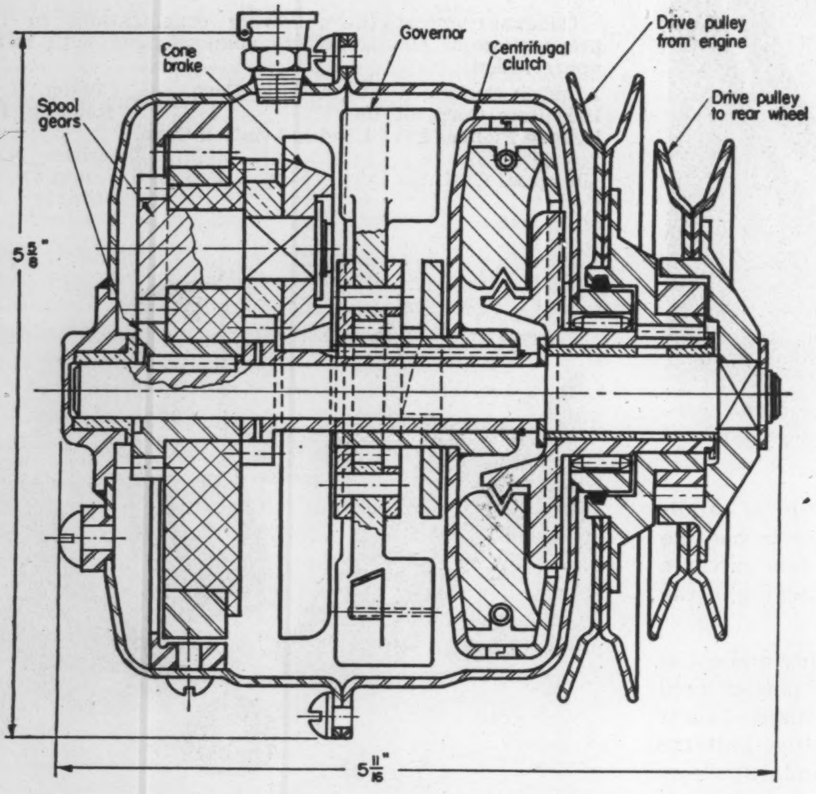


Fig. 1—Above—Two-speed transmission shown in direct-drive position with cone brakes and spool gears locked

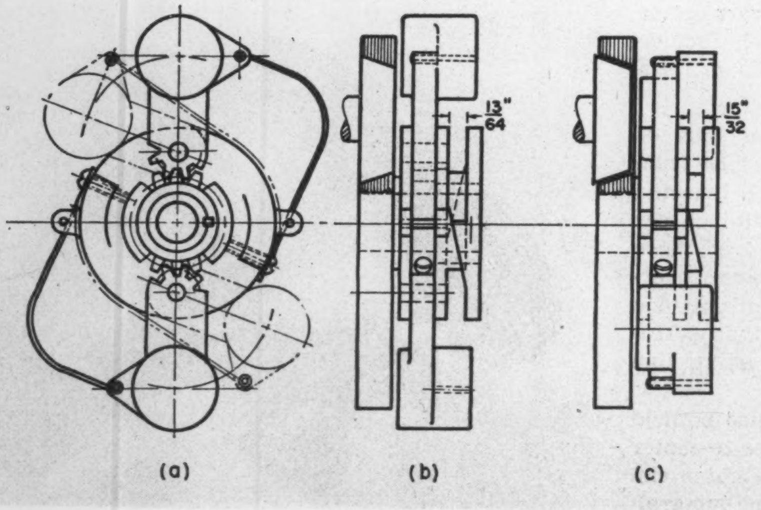
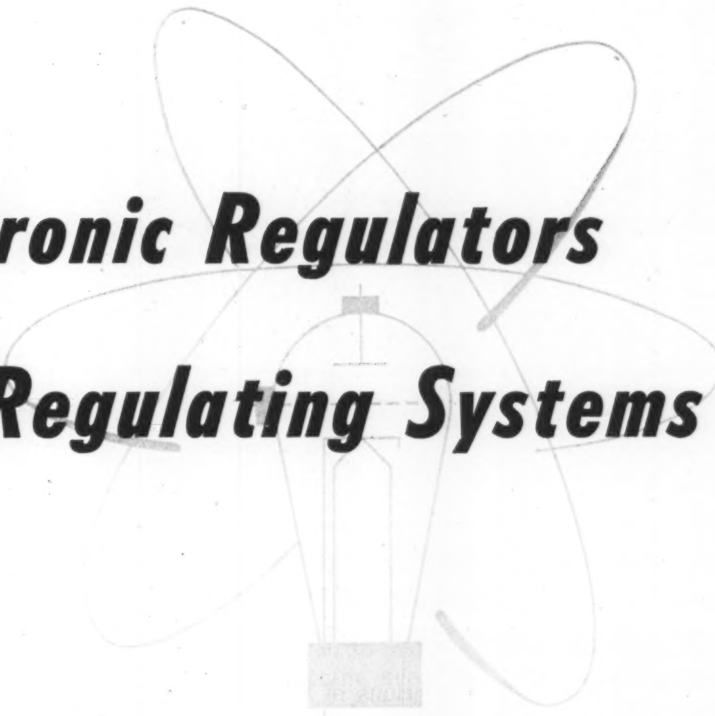


Fig. 2—Left — Governor mechanism mounted on input shaft to transmission which actuates the braking disk to lock the cone brakes

Electronic Regulators and Regulating Systems



By W. G. Roman
Westinghouse Electric Corp.
Buffalo, N. Y.

ELECTRONIC regulators have found their greatest use in the continuous process industries such as steel, paper, rubber, packaging and printing. Regulators inherently operate continuously or very repetitively. Thus, they impose severe duty on any electromechanical device. The use of electronic circuits to perform the precision and repetitive functions materially improves the performance and reliability of the regulator. Many regulating problems such as automatic color register on multicolor presses could not be solved except electronically.

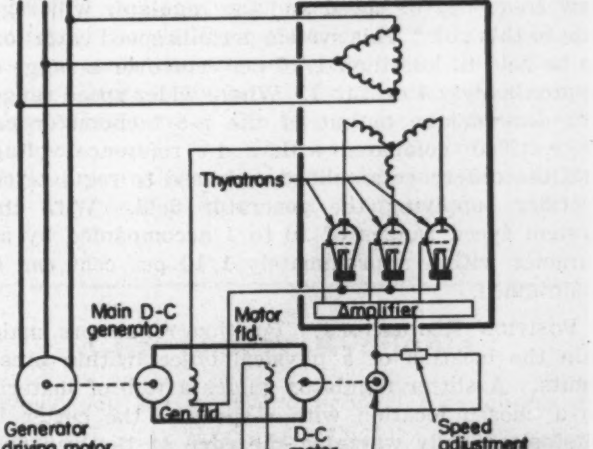
Process regulators can be conveniently divided into four classes:

1. Quantity
2. Position
3. Quantity matching
4. Position matching

QUANTITY REGULATORS: These devices regulate the magnitude of variables such as voltage, current, frequency, speed and temperature.

A typical speed regulator of this class, *Fig.* 1, would consist of a d-c motor, a motor-generator set for supplying the power to the motor, an electronic regulator, and an a-c tachometer generator coupled to the motor for indicating the speed. The motor

Fig. 1—Electronic speed regulating system can hold speed variations within accuracy of 1/10 per cent over range of 4 or 5 to 1


3-phase
A-C supply
Speed regulator
Thyratrons
Amplifier
Main D-C generator
Motor fld.
Gen fld
Generator driving motor
D-C motor
Speed adjustment potentiometer
To D-C exciter generator on motor generator set
Speed indicating generator

This article is based on a paper presented at AIEE Conference on Industrial Application of Electron Tubes, Buffalo, April 11 and 12.

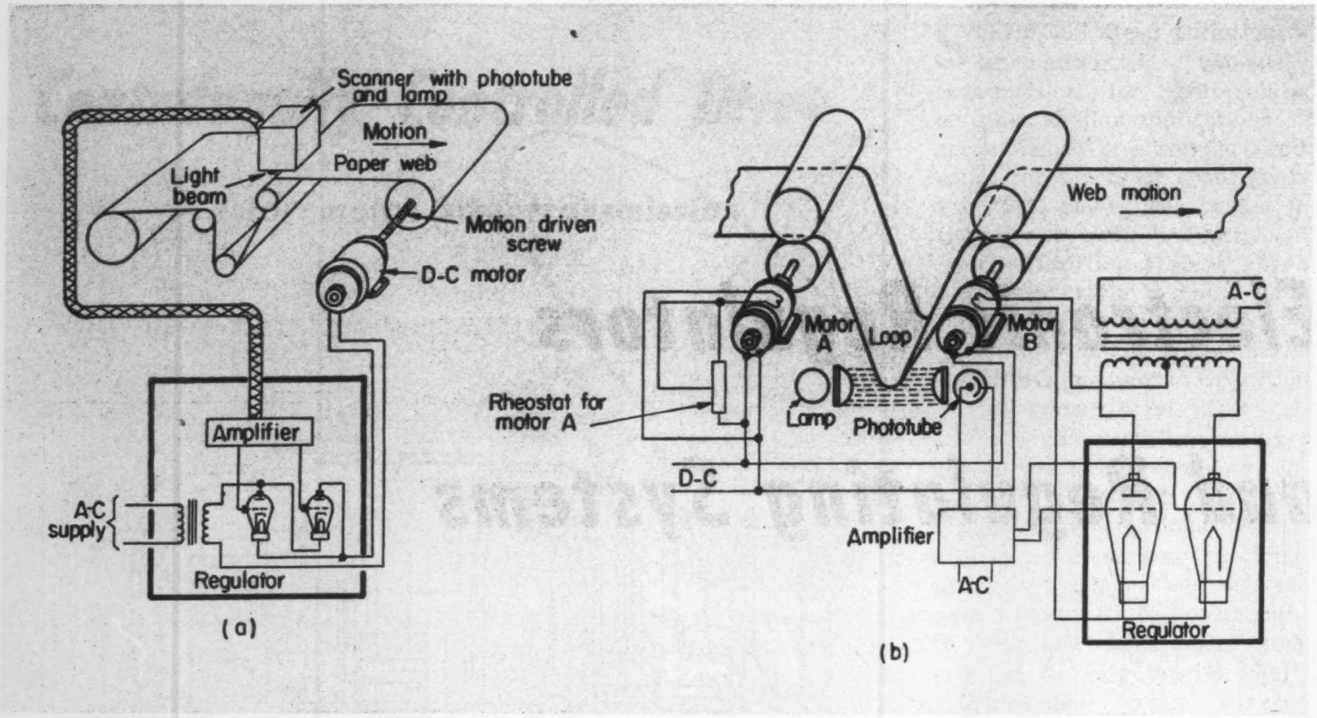

Scanner with phototube and lamp
Motion
Paper web
Light beam
Motion driven screw
D-C motor
Amplifier
A-C supply
Regulator
(a)
Web motion
A-C
Motor A
Loop
Motor B
Rheostat for motor A
Lamp
Phototube
D-C
Amplifier
A-C
Regulator
(b)

Fig. 2—In both edge regulator (a) and loop regulator (b), phototube is used to sense shifts in position of material

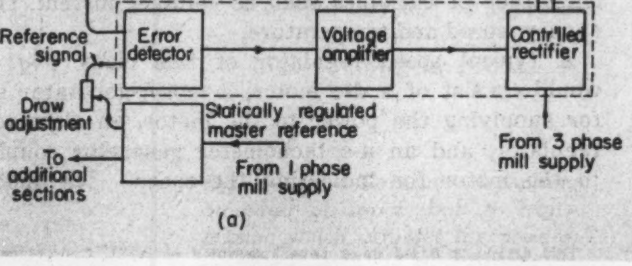
field would be supplied with a constant voltage by means of an exciter. Generator field current and therefore the power supplied to the motor armature is regulated by the electronic exciter. Motor speed is indicated by the a-c tachometer whose output voltage and frequency is proportional to speed. The tachometer voltage is applied to a frequency-sensitive bridge network. When the tachometer frequency differs from the frequency for which the bridge is balanced, a small signal voltage appears across the bridge.

This signal voltage is amplified and used to control the rectifier supplying the generator field. Speed can be changed by changing one of the constants in the bridge network. The bridge will then balance at a new frequency or speed and the regulator will regulate to this point. This system permits speed variations to be held to less than 1/10 per cent over a range of approximately 4 or 5 to 1. Where wider speed ranges are desired, the output of the a-c tachometer can be rectified, compared with a d-c reference voltage and the difference amplified and used to regulate the rectifier supplying the generator field. With this system speed ranges of 10 to 1 accompanied by accuracies within approximately 1/10 per cent can be maintained.

POSITION REGULATORS: Position regulators maintain the location of a physical object within preset limits. A slitter regulator guides a web of material to a chosen location with respect to the cutter by photoelectrically watching the edge of the web or a line printed on the web. A similar device, *Fig. 2a*, will guide a web on a winder so as to reel evenly. The loop regulator on a paper-coating machine, *Fig. 2b*, or on a steel strip mill, watches the loop position and calls for slowing down or speeding up one of the sections of the mill to maintain a constant loop. An increase in the length of loop reduces the amount of light reaching the phototube from the light source. The change in phototube current is amplified and used to modify the field excitation of the motor driving one section of the line. This changes the motor speed and brings the loop back to its proper position.

QUANTITY MATCHING REGULATORS: These regulators are used to insure that two or more quantities match each other. Frequently, it is desired to adjust the speed, voltage, current, or frequency of one element of a system and have one or more additional elements equal or bear a chosen relation to the first element. This is especially important in continuous processing lines such as steel, paper, rubber and photographic film.

An important example of this type of regulator is


To starting generator
S
To running generator
R
Electronically regulated armature bus
Section motor
Electronically regulated excitation bus
Section tachometer
To other tachometer fields
Speed signal
Reference signal
Error detector
Voltage amplifier
Contr'lled rectifier
Draw adjustment
Statically regulated master reference
To additional sections
From I phase mill supply
From 3 phase mill supply
(a)

the paper mill section drive regulator, *Fig. 3a.* In this system, the speed of each section of the paper mill is regulated to a preset ratio with respect to the speed of a master reference. The armature power for all of the section drive motors as well as the motor of the master reference set is furnished from a main motor generator. The overall mill speed is adjusted by the control of the field of the main set.

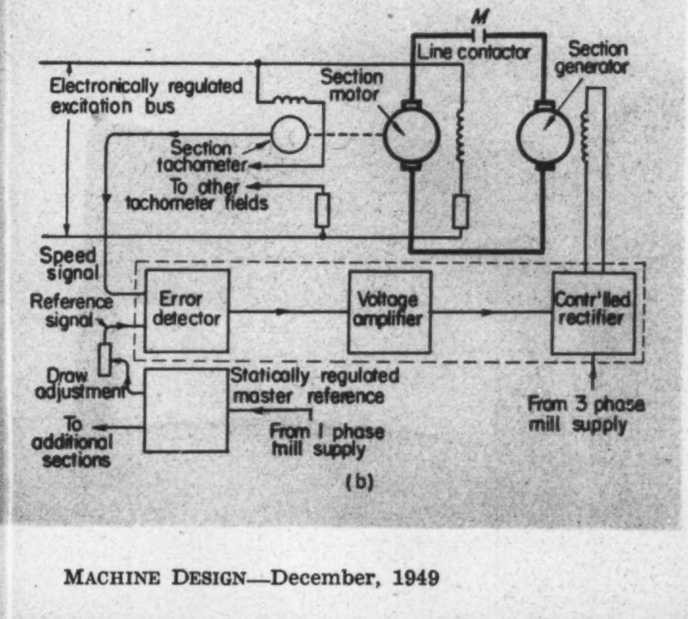
Regulator Compares Speed with Tachometer

A cue tachometer is attached to each section drive motor. The regulator consists of a separate regulating circuit for each section of the mill. For each section, the regulator compares the speed indication from the master reference with that from the cue tachometer for that section. The regulator supplies the correct field current to each section driving motor to maintain a chosen speed ratio between the master and the section. An accuracy of match within 1/10 per cent is maintained.

Position Matching Regulators: A regulator is frequently used in the paper, cellophane, and glassine packaging industry for maintaining the position of cut when taking stock from a preprinted roll to make bags and packages. Although the machine feeds paper at a rate approximately correct to match the speed of the cutter knife, the cut will never remain registered perfectly without either manual or automatic supervision. A register regulator, *Fig.* 4, corrects for minor changes due to paper slippage, stretch, and proper speed relative to the cutter speed. The position of the printed material is indicated by a rectangular register mark in the design or margin which is scanned by a phototube. Position of the mark with respect to the cutter is checked and the speed of the paper feed modified as necessary.

Another important application for this class of regulator is for maintaining the register of the several colors in a multicolor printing press, *Fig.* 5. In this system, yellow is printed by the cylinder in the first press section and each succeeding press section adds another color the location of which must be accurately matched to the original yellow. As the yellow is printed, a series of yellow register marks is simultaneously imprinted on the paper web. A scanner at each succeeding press section detects the position of the yellow register mark. The regulator then compares the scanner signal with that from a reference pickup attached to the printing cylinder and makes adjustment of the loop of paper between cylinders to match the time occurrence of the two signals. A register accuracy within approximately three thousandths of an inch is maintained.

Fig. 3—Electronic paper-mill section regulators match speeds of various sections within accuracy of 1/10 per cent. Single-generator drive is shown at (a); multiple-generator drive is shown at (b)


M
Line contactor
Section generator
Section motor
Electronically regulated excitation bus
Section tachometer
To other tachometer fields
Speed signal
Reference signal
Error detector
Voltage amplifier
Contr'lled rectifier
Draw adjustment
Statically regulated master reference
From 1 phase mill supply
From 3 phase mill supply
To additional sections
(b)

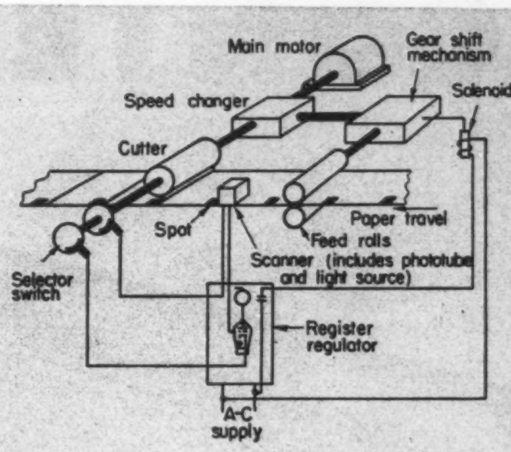
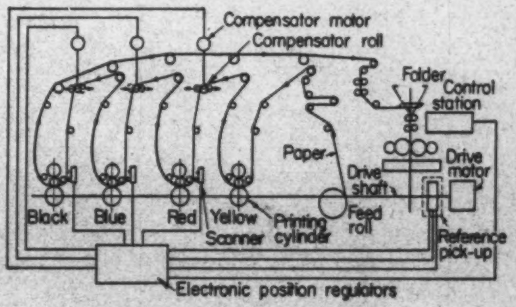

Main motor
Gear shift mechanism
Speed changer
Solenoid
Cutter
Spot
Paper travel
Feed rolls
Scanner (includes phototube and light source)
Selector switch
Register regulator
A-C supply

Fig. 4—Above—Single-direction register regulator for bag machine in which signals from scanner control paper feed units to insure proper positioning

Fig. 5—Below—Multicolor press register regulator insures register accuracy within 0.003-inch


Compensator motor
Compensator roll
Folder
Control station
Paper
Drive shaft
Drive motor
Black
Blue
Red
Yellow
Scanner
Printing cylinder
Feed roll
Reference pick-up
Electronic position regulators

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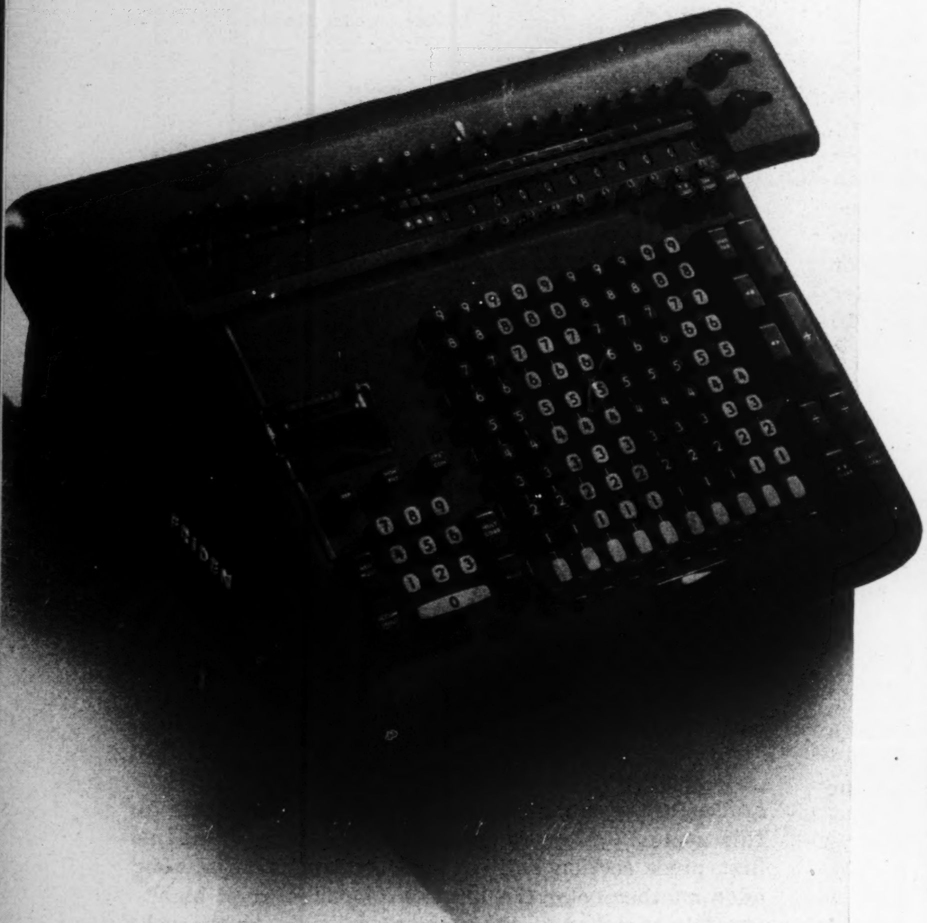
CONTEMPORARY

. . . as represented by modern



Fully automatic multiplication, division, addition and subtraction features make this Friden calculator, left, a time-saver in engineering, accounting, statistical, and other office figure work. Machine is "color-engineered" to reduce operator fatigue and includes special-shape Tenite keys for additional ease of operation. Both 8 and 10-bank models are available. Manufacturer: Friden Calculating Machine Co., San Leandro, Calif.

Envelope sealer for all standard-size envelopes, below, features a water feed which assures a uniform flow of water to the gummed flap. All excess water is returned to the tank. A rubber belt accurately feeds the envelopes at high speed under the metal sealing blade. As in the companion envelope opener, self-lubricating bearings contribute to smooth and quiet operation. Manufacturer: Commercial Controls Corp., Rochester, N. Y.

Envelope opener, below, right, for automatically opening and stacking thousands of letters per hour. Dial may be set for light, medium or heavy cut. The accurate feeding mechanism of the opener assures uniform cutting along the full length of the envelope without damage to the contents. The machine is styled in a

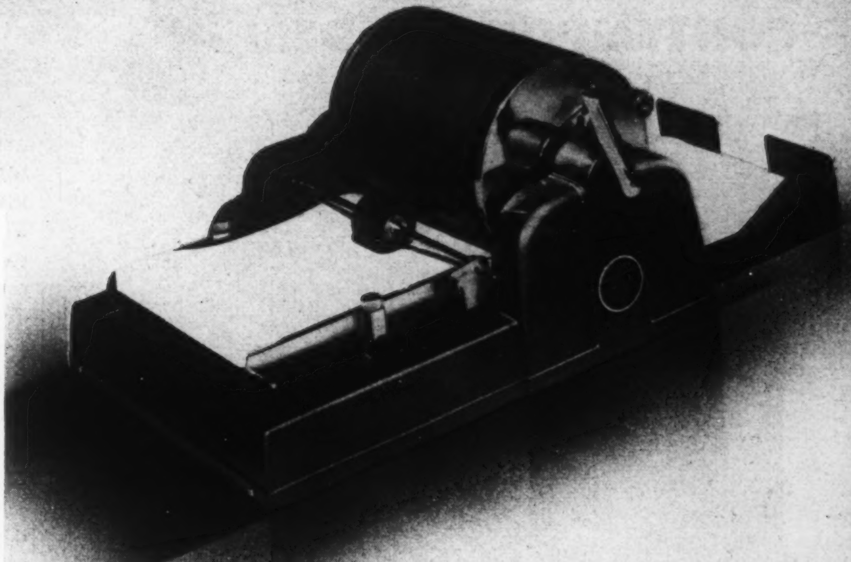
multiSealer

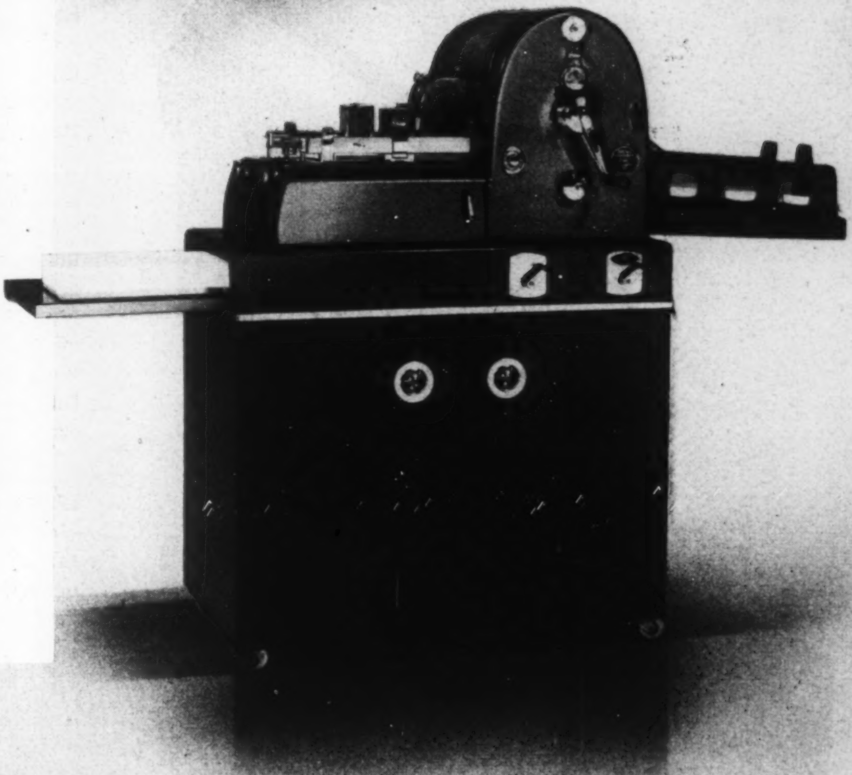
DESIGN

business machine styling

gray wrinkle finish with satin stainless-steel trim. Manufacturer: Commercial Controls Corp., Rochester, N. Y.

Largest and smallest members of a new line of Mimeograph office duplicators, right, which are capable of increased speed, improved registration, more efficient feeding and inking, and offer better convenience and safety. Machines weigh 25 per cent more than previous models; heavier tie members, frames, cams and gears result in a sturdier machine. Mechanical functions are controlled by a balanced cam system which results in spreading the load more evenly over the duplicating cycle; this cam replaces a single cam and multiple-follower system previously used which resulted in unbalanced torque. The printing cylinder of the larger model has been enclosed, permitting more print adjustment, a more constant impression-roller pressure, and improved safety conditions. A new roll feed replaces the swinging push feed of earlier models, providing more positive feeding and allowing the use of short lengths of paper without the usual buckle. The entire line of seven new duplicators and their accessories have been similarly and distinctively styled by industrial designer Walter Dorwin Teague. Manufacturer: A. B. Dick, Chicago, Ill.





multi Opener

CONTEMPORARY DESIGN

Clean-lined cash register, left, for item-adding and receipt-issuing use. Far left row of nine keys is for classifications or departments, next row for clerk identification, and following six rows are amount keys. Five control keys are grouped in right column. The register has lock controls for the total key and visible total, detail-strip records, cash drawer, and cash-drawer compartment. Manufacturer: The McCaskey Register Co., Alliance, O.

Cash register, below, left, incorporating a mechanized adding feature which can be used without disturbing the locked-in, protected cash register total. Eight classifiacation keys automatically segregate sales and other transactions into separate columns. Keys in various colors designate cash, charge, received-on-account, miscellaneous credit, paid-out, and no-sale transactions. Clerk number, sales-slip number, quantities, weights, and cost figures can be recorded by using a descriptive key section and additional information can be written directly on the detailed audit slip. Manufacturer: The National Cash Register Co., Dayton, O.

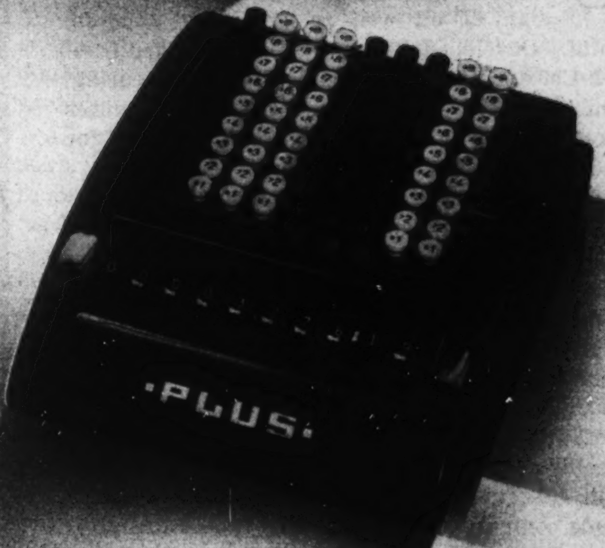
Electric adding machine, below, with unusually compact keyboard. Pyramidal keys and contrasting colors permit space saving arrangement with no loss in legibility. Chances of making errors are lessened by making the controls a distinguishable shape from the numeral keys. A thumb add bar is included as well as the customary add bar on the right side, with twin total bars, one on each side, as an added feature. Manufacturer: Clary Multiplier Corp., Los Angeles, Calif.

Cardatype machine, below, right, using prepunched IBM cards to prepare documents automatically on an electric typewriter. The machine accurately transcribes repetitive information at 10 characters a second or 120 words per minute. A tape controls reading

of the cards and typing of the information desired in the correct position on the document. The machine can be programmed to stop at any given time to allow the operator to type in variable information. When desired, a second typewriter can be connected to the basic unit for the automatic preparation of a different type of document requiring the same information. Simultaneously with the typing operation, a transmittal tape can be punched to permit cards to be made containing the same information as was typed on the documents. Manufacturer: International Business Machine Corp., New York, N. Y.

Key-actuated type adding machine, center, right, permits rapid addition, multiplication and subtraction because of direct key-to-dial registration. Keys are banked for fast and comfortable operation, with the "1" and "9" keys specially placed to permit easier locating. Nine-column models weigh 14 pounds with one-piece steel cases. Manufacturer: Plus Computing Machines Inc., New York, N. Y.

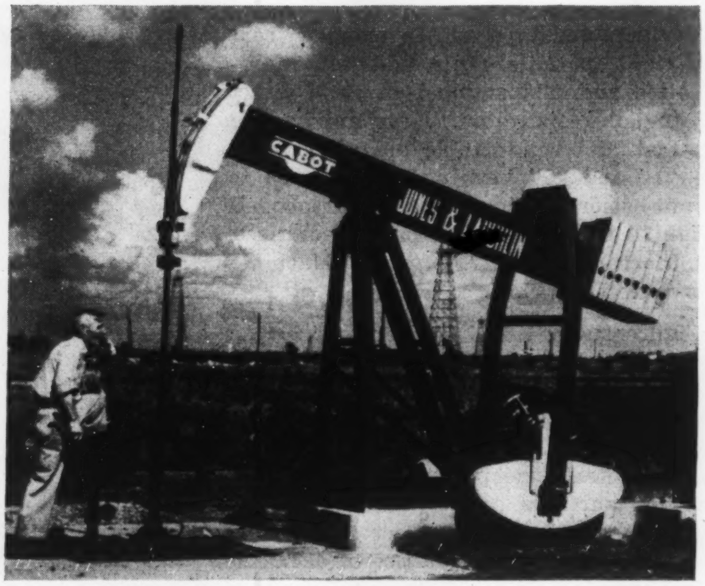
Figuremaster calculator for engineering and commercial use, top, right, solves the question of where the decimal point should be placed in division. At the completion of the problem the carriage automatically positions itself and points off the decimal. The top surfaces of the Tenite keys are slanted to create a step effect on the keyboard, minimizing the chances of accidentally depressing two keys at once. Columnar divisions of the keyboard are indicated by colored keys. Manufacturer: Marchant Calculating Machine Co., Oakland, Calif.



PRODUCTION AND DESIGN

Modern Practices in Manufacture

Design with Rubber

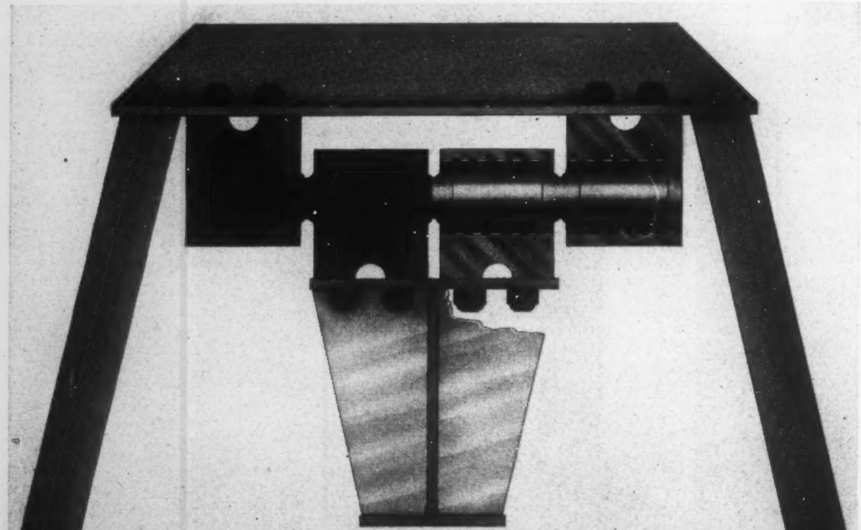


View of the Cabot oil well pumping unit equipped with rubber evener bearings on test on a 3500-foot well in Texas

UTILIZATION of a rubber bearing mounted rocker arm has radically simplified the design of oil well reciprocating pumping units. Developed jointly by United States Rubber Co. and Cabot Shops Inc., the new bearing, which is used in the evener assembly, reduces from 100 to 38 the number of parts required for the pumping unit.

Field tests in west Texas, Panhandle and Louisiana oil fields have shown that the rubber bearing provides more than 200 per cent greater wear life than the standard installation using a conventional mounting with needle bearings. The rubber evener bearing, under unusually severe operating conditions, completed more than 40,000,000 cycles, outwore many of the structural metal parts in the unit and still maintained serviceable operating conditions. It was also found that the rubber bearing greatly reduced shock loads compared to the standard type bearing.

In addition to the economies effected by the simplification of pumping unit design and longer wear, rubber was selected for bearing construction for the following reasons: To eliminate lubrication since the assembly needs no sliding or rolling parts, to obtain corrosion and abrasion resistance, to insulate the drive from well shocks, to eliminate the need for elaborate assembly, to provide for misalignment, and to obviate initial friction and excessive wear.



Left—Cross section through the evener bearing assembly showing the four rubber bearings and simplified assembly design

Hydraulic Packings for Industrial Equipment

By J. N. Smith
Manager
Hydraulic and Transmission Div.
E. F. Houghton & Co.
Philadelphia, Pa.

STANDARDIZATION of hydraulic packings by sizes and types, to simplify selection and reduce sizes and inventories, has been worked out over the past year by the manufacturers of packings under the auspices of the Joint Industry Conference on Hydraulic Standards for Industrial Equipment. This is primarily an attempt to aid designers, and users of packings, rather than merely to alleviate problems of the packing suppliers. Firms who build or utilize hydraulically operated equipment and experience considerable difficulty in stocking original or replacement packings for such units should find this new development of distinct value.

Experience with packing designs over many years has shown that the sealing of hydraulic elements is too often the last consideration. Because of confusion or lack of the necessary information, common drawing practice has been to leave a space to indicate some sort of packing installation, a packing manufacturer being consulted for recommendations after all other phases of the design had been worked out. One possible result was ineffective design; a definite result was a multiplicity of special sizes.

Of five basic packing designs—U, V, Cup, Flange, and O-ring—each equipment manufacturer over the years had built up his own list of sizes required, and there was little uniformity between them. Recommended diameters and cross-sections varied widely and interchangeability was impossible. In specifying packings, it was necessary to give complete dimensions rather than simple standard numbers.

To release machine hydraulics development from these severe stumbling blocks it was fully appreciated that standardization was both desirable and necessary. Starting with the Army-Navy (AN) packing specifications for aircraft, established during the war, the JIC project was developed to cover all types and sizes of leather and synthetic rubber packings. The results, which are based on a plan set up by Houghton engineers, are set forth in the tables of this Data Sheet.

Packings of one basic style or design, with few exceptions, have the same proportions and are therefore interchangeable. One variation is found in fabricated V-packings, where manufacturers' varying designs cause differences in stack heights. However, by slight modification the overall height per set can be predetermined. Most important is the fact that diameters and cross-sections are standard for all V-packings.

Along with standardization of various types and sizes, standard dash numbers have been established to facilitate specifying and ordering. No dimensions need be used, except with cups where the hole may vary, and it is only necessary to order a specific "Dash Number" by type and specify the service. The same dash number applies to the same size packing in both fabricated and leather cup styles, and also to leather, fabricated or homogeneous synthetic rubber V-packing. The number of sizes has been greatly reduced. Thus, fewer molds are required and greater economy is obtained. In addition, inventories of packings will be greatly simplified and prompt deliveries can be assured.

The last item of importance to the designer and to the user of packings is the coding system which at this writing is nearing completion. This system comprises the use of a metal plate, similar to the type commonly used for lubrication instructions on a machine, on all hydraulic units to convey the specifications of the packing used. This makes reordering much easier, and removes the necessity of tearing down the unit to determine size and style of packing required. The code will have symbols to be struck into the soft metal plate showing: (1) Type of packing material (leather or homogeneous or fabricated synthetic rubber), (2) design (U, V, Cup, Flange or O-ring), and (3) standard dash number to indicate exact size. All these sizes and dash numbers are being set up to tie in with AN sizes where dash numbers are already in use, so there can be no confusion between commercial and AN standards.

There are still a few details to be worked out on coding, stack height, stuffing box design, etc., but the major job has been done, and when understood and followed it should prove of definite advantage to all users of packing, and to the hydraulic industry generally.

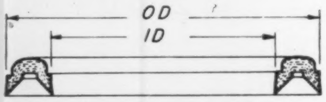
HYDRAULIC AND PNEUMATIC PACKING STANDARDS
Leather and Synthetic Rubber

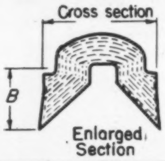
Recommended Number of V Packings per Set

Pressure (psi)	Leather	Synthetic Rubber Homogeneous	Synthetic Rubber Fabricated
Zero to 500	3	3	3
500 to 1500	4	4	4
1500 to 3000	4	5	4
3000 to 5000	4	6	5
5000 to 10,000	5		6
10,000 and over	6		

All V packings should be made solid (not split).

STANDARD SIZES FOR FABRICATED V PACKINGS

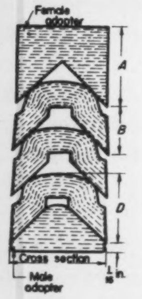




Dash No.	Cross Section	ID	OD	B
8	¼	¼	¾	.156
10	¼	⅜	⅞	.156
12	¼	½	1	.156
14	¼	⅝	1⅛	.156
16	¼	¾	1¼	.156
18	¼	⅞	1⅜	.156
20	¼	1	1½	.156
22	¼	1⅛	1⅝	.156
24	¼	1¼	1¾	.156
25	5/16	1¼	1⅞	.188
26	5/16	1⅜	2	.188
27	5/16	1½	2⅛	.188
28	5/16	1⅝	2¼	.188
29	5/16	1¾	2⅜	.188
30	5/16	1⅞	2½	.188
31	5/16	2	2⅝	.188
32	5/16	2⅛	2¾	.188
33	5/16	2¼	2⅞	.188
34	5/16	2⅜	3	.188
35	5/16	2½	3⅛	.188
36	⅜	2½	3¼	.219
38	⅜	2¾	3½	.219
40	⅜	3	3¾	.219
42	⅜	3¼	4	.219
44	⅜	3½	4¼	.219
46	⅜	3¾	4½	.219
49	7/16	4	4⅞	.25
50	7/16	4¼	5⅛	.25
51	7/16	4½	5⅜	.25
52	7/16	4¾	5⅝	.25
53	7/16	5	5⅞	.25
54	7/16	5¼	6⅛	.25
55	7/16	5½	6⅜	.25
56	½	5½	6½	.266
58	½	6	7	.266
60	½	6½	7½	.266
62	½	7	8	.266
64	½	7½	8½	.266
66	½	8	9	.266
67	½	8½	9½	.266
68	½	9	10	.266
69	½	9½	10½	.266
70	½	10	11	.266
71	½	10½	11½	.266
72	½	11	12	.266
74	½	12	13	.266
76	½	13	14	.266
78	½	14	15	.266
80	½	15	16	.266

NOTE: The above are standard commercial sizes recommended for new designs. Other sizes for equipment already in use are available.

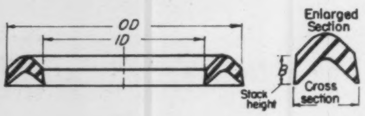
PROPORTIONS FOR FABRICATED V PACKINGS



Cross Section	A	B	D
3/16	3/16	.109	5/32
¼	¼	.156	7/32
5/16	5/16	.188	17/64
⅜	5/16	.219	5/16
7/16	⅜	.25	11/32
½	7/16	.266	⅜
9/16	7/16	.266	13/32
⅝	½	.213	15/32
11/16	½	.344	½
¾	⅝	.375	9/16
13/16	⅝	.406	19/32
⅞	¾	.438	21/32
15/16	¾	.469	23/32
1	⅞	.50	¾
1 1/16	⅞	.531	25/32
1⅛	1	.563	27/32
1 3/16	1⅛	.594	⅞
1¼	1⅛	.625	15/16
1 5/16	1¼	.656	31/32
1⅜	1¼	.688	1 1/32
1 7/16	1⅜	.719	1 1/16
1½	1⅜	.75	1 3/32

NOTE: Each set consists of male and female adapters and necessary number of packings to equal required depth.

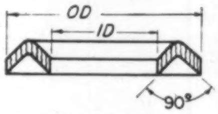
STANDARD SIZES FOR HOMOGENEOUS V PACKINGS

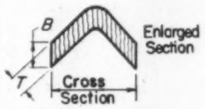


Dash No.	Cross Section	I.D. (Nom)	O.D. (Nom)	B ±.010
8	¼	¼	¾	.083
10	¼	⅜	⅞	.083
12	¼	½	1	.083
14	¼	⅝	1⅛	.083
16	¼	¾	1¼	.083
18	¼	⅞	1⅜	.083
20	¼	1	1½	.083
22	¼	1⅛	1⅝	.083
24	¼	1¼	1¾	.083
25	5/16	1¼	1⅞	.140
26	5/16	1⅜	2	.140
27	5/16	1½	2⅛	.140
28	5/16	1⅝	2¼	.140
29	5/16	1¾	2⅜	.140
30	5/16	1⅞	2½	.140
31	5/16	2	2⅝	.140
32	5/16	2⅛	2¾	.140
33	5/16	2¼	2⅞	.140
34	5/16	2⅜	3	.140
35	5/16	2½	3⅛	.140
36	⅜	2½	3¼	.156
38	⅜	2¾	3½	.156
40	⅜	3	3¾	.156
42	⅜	3¼	4	.156
44	⅜	3½	4¼	.156
46	⅜	3¾	4½	.156
49	7/16	4	4⅞	.197
50	7/16	4¼	5⅛	.197
51	7/16	4½	5⅜	.197
52	7/16	4¾	5⅝	.197
53	7/16	5	5⅞	.197
54	7/16	5¼	6⅛	.197
55	7/16	5½	6⅜	.197
56	½	5½	6½	.197
58	½	6	7	.197
60	½	6½	7½	.197
62	½	7	8	.197
64	½	7½	8½	.197
66	½	8	9	.197
67	½	8½	9½	.197
68	½	9	10	.197
69	½	9½	10½	.197
70	½	10	11	.197
71	½	10½	11½	.197
72	½	11	12	.197
74	½	12	13	.197
76	½	13	14	.197
78	½	14	15	.197
80	½	15	16	.197

NOTE: The table shows standard commercial sizes recommended for new designs. Other sizes for equipment already in use are available. The 49 tabulated sizes, together with the 31 intermediate dash numbers, correspond to AN-6225.

STANDARD SIZES FOR LEATHER V PACKINGS





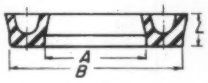
Dash No.	Cross Section	I.D. (Nom)	O.D. (Nom)	B ±.010
8	¼	¼	¾	.083
10	¼	⅜	⅞	.083
12	¼	½	1	.083
14	¼	⅝	1⅛	.083
16	¼	¾	1¼	.083
18	¼	⅞	1⅜	.083
20	¼	1	1½	.083
22	¼	1⅛	1⅝	.083
24	¼	1¼	1¾	.083
25	5/16	1¼	1⅞	.140
26	5/16	1⅜	2	.140
27	5/16	1½	2⅛	.140
28	5/16	1⅝	2¼	.140
29	5/16	1¾	2⅜	.140
30	5/16	1⅞	2½	.140

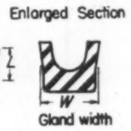
Dash No.	Cross Section	I.D. (Nom)	O.D. (Nom)	B ±.010
31	5/16	2	2⅝	.140
32	5/16	2⅛	2¾	.140
33	5/16	2¼	2⅞	.140
34	5/16	2⅜	3	.140
35	5/16	2½	3⅛	.140
36	⅜	2½	3¼	.156
38	⅜	2¾	3½	.156
40	⅜	3	3¾	.156
42	⅜	3¼	4	.156
44	⅜	3½	4¼	.156
46	⅜	3¾	4½	.156
49	7/16	4	4⅞	.197
50	7/16	4¼	5⅛	.197
51	7/16	4½	5⅜	.197
52	7/16	4¾	5⅝	.197

Dash No.	Cross Section	I.D. (Nom)	O.D. (Nom)	B ±.010
53	7/16	5	5⅞	.197
54	7/16	5¼	6⅛	.197
55	7/16	5½	6⅜	.197
56	½	5½	6½	.197
58	½	6	7	.197
60	½	6½	7½	.197
62	½	7	8	.197
64	½	7½	8½	.197
66	½	8	9	.197
67	½	8½	9½	.197
68	½	9	10	.197
69	½	9½	10½	.197
70	½	10	11	.197
71	½	10½	11½	.197
72	½	11	12	.197
74	½	12	13	.197
76	½	13	14	.197
78	½	14	15	.197
80	½	15	16	.197

NOTE: The above are standard commercial sizes rccommended for new designs. Other sizes for equipment already in use are available.

STANDARD SIZES FOR HOMOGENEOUS U CUP PACKINGS



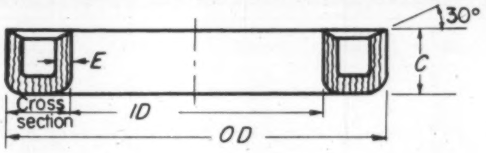


Dash No.	W & L	I.D. (Nom.)	O.D. (Nom.)	Diameters ± .005 A	Diameters ± .005 B
8	¼	¼	¾	.265	.735
10	¼	⅜	⅞	.390	.860
12	¼	½	1	.515	.985
14	¼	⅝	1⅛	.640	1.110
16	¼	¾	1¼	.765	1.235
18	¼	⅞	1⅜	.890	1.360
20	¼	1	1½	1.015	1.485
22	¼	1⅛	1⅝	1.140	1.610

Dash No.	W & L	I.D. (Nom.)	O.D. (Nom.)	Diameters ± .005 A	Diameters ± .005 B
24	¼	1¼	1¾	1.265	1.735
25	5/16	1¼	1⅞	1.265	1.860
26	5/16	1⅜	2	1.390	1.985
27	5/16	1½	2⅛	1.515	2.110
28	5/16	1⅝	2¼	1.640	2.235
29	5/16	1¾	2⅜	1.765	2.360
30	5/16	1⅞	2½	1.890	2.485
31	5/16	2	2⅝	2.015	2.610
32	5/16	2⅛	2¾	2.140	2.735
33	5/16	2¼	2⅞	2.265	2.860
34	5/16	2⅜	3	2.390	2.985
35	5/16	2½	3⅛	2.515	3.110
36	⅜	2½	3¼	2.515	3.235
38	⅜	2¾	3½	2.765	3.485
40	⅜	3	3¾	3.015	3.735

Note: The table shows standard commercial sizes recommended for new designs. The 23 tabulated sizes, together with the 30 other dash numbers in the range from 1 to 53, correspond to AN 6226.

STANDARD SIZES FOR LEATHER U PACKINGS

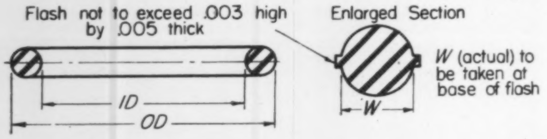


Dash No.	Cross Section	ID	OD	C	E
12	¼	½	1	5/16	1/16
14	¼	⅝	1⅛	5/16	1/16
16	¼	¾	1¼	5/16	1/16
18	¼	⅞	1⅜	5/16	1/16
20	⅜	1	1¾	⅜	3/32
22	⅜	1⅛	1⅞	⅜	3/32
24	⅜	1¼	2	⅜	3/32
26	⅜	1⅜	2⅛	⅜	3/32
27	⅜	1½	2¼	⅜	3/32
28	⅜	1⅝	2⅜	⅜	3/32
29	⅜	1¾	2½	⅜	3/32
30	½	1⅞	2⅞	7/16	⅛
31	½	2	3	7/16	⅛
32	½	2⅛	3⅛	7/16	⅛
33	½	2¼	3¼	7/16	⅛
34	½	2⅜	3⅜	7/16	⅛
36	½	2½	3½	½	⅛
38	½	2¾	3¾	½	⅛
40	½	3	4	½	⅛

Dash No.	Cross Section	ID	OD	C	E
42	½	3¼	4¼	½	⅛
44	½	3½	4½	½	⅛
46	½	3¾	4¾	½	⅛
49	⅝	4	5¼	⅝	5/32
50	⅝	4¼	5½	⅝	5/32
51	⅝	4½	5¾	⅝	5/32
52	⅝	4¾	6	⅝	5/32
53	⅝	5	6¼	⅝	5/32
54	⅝	5¼	6½	⅝	5/32
55	⅝	5½	6¾	⅝	5/32
56	¾	5½	7	¾	3/16
58	¾	6	7½	¾	3/16
60	¾	6½	8	¾	3/16
62	¾	7	8½	¾	3/16
64	¾	7½	9	¾	3/16
66	¾	8	9½	¾	3/16
67	¾	8½	10	¾	3/16
68	¾	9	10½	¾	3/16
69	¾	9½	11	¾	3/16
70	¾	10	11½	¾	3/16
71	¾	10½	12	¾	3/16
72	¾	11	12½	¾	3/16
74	¾	12	13½	1	3/16
76	¾	13	14½	1	3/16
78	¾	14	15½	1	3/16
80	¾	15	16½	1	3/16

NOTE: The above are standard commercial sizes recommended for new designs. Other sizes for equipment already in use are available.

STANDARD SIZES FOR O RING PACKINGS


Flash not to exceed .003 high by .005 thick
Enlarged Section
ID
OD
W (actual) to be taken at base of flash
W

Dash No.	W	ID	OD	W	ID
1	1/16	1/8	1/4	.070±.003	.114±.005
2	1/16	5/32	9/32	.070±.003	.145±.005
3	1/16	3/16	5/16	.070±.003	.176±.005
4	1/16	7/32	11/32	.070±.003	.208±.005
5	1/16	1/4	3/8	.070.±003	.239±.005
6	1/16	5/16	7/16	.070±.003	.301±.005
7	1/16	3/8	1/2	.070±.003	.364±.005
8	3/32	3/8	9/16	.103±.003	.362±.005
9	3/32	7/16	5/8	.103±.003	.424±.005
10	3/32	1/2	11/16	.103±.003	.487±.005
11	3/32	9/16	3/4	.103±.003	.549±.005
12	3/32	5/8	13/16	.103±.003	.612±.005
13	3/32	11/16	7/8	.103±.003	.674±.005
14	3/32	3/4	15/16	.103±.003	.737±.005
15	1/8	3/4	1	.139±.004	.734±.006
16	1/8	13/16	1 1/16	.139±.004	.796±.006
17	1/8	7/8	1 1/8	.139±.004	.859±.006
18	1/8	15/16	1 3/16	.139±.004	.921±.006
19	1/8	1	1 1/4	.139±.004	.984±.006
20	1/8	1 1/16	1 5/16	.139±.004	1.046±.006
21	1/8	1 1/8	1 3/8	.139±.004	1.109±.006
22	1/8	1 3/16	1 7/16	.139±.004	1.171±.006
23	1/8	1 1/4	1 1/2	.139.±004	1.234±.006
24	1/8	1 5/16	1 9/16	.139±.004	1.296±.006
25	1/8	1 3/8	1 5/8	.139±.004	1.359±.006
26	1/8	1 7/16	1 11/16	.139±.004	1.421±.006
27	1/8	1 1/2	1 3/4	.139±.004	1.484±.006
28	3/16	1 1/2	1 7/8	.210±.005	1.475±.010
29	3/16	1 5/8	2	.210±.005	1.600±.010
30	3/16	1 3/4	2 1/8	.210±.005	1.725±.010
31	3/16	1 7/8	2 1/4	.210±.005	1.850±.010
32	3/16	2	2 3/8	.210.±005	1.975±.010
33	3/16	2 1/8	2 1/2	.210±.005	2.100±.010
34	3/16	2 1/4	2 5/8	.210±.005	2.225±.010
35	3/16	2 3/8	2 3/4	.210±.005	2.350±.010
36	3/16	2 1/2	2 7/8	.210±.005	2.475±.010
37	3/16	2 5/8	3	.210±.005	2.600±.010
38	3/16	2 3/4	3 1/8	.210±.005	2.725±.015
39	3/16	2 7/8	3 1/4	.210±.005	2.850±.015
40	3/16	3	3 3/8	.210±.005	2.975±.015
41	3/16	3 1/8	3 1/2	.210±.005	3.100±.015
42	3/16	3 1/4	3 5/8	.210±.005	3.225±.015
43	3/16	3 3/8	3 3/4	.210±.005	3.350±.015
44	3/16	3 1/2	3 7/8	.210±.005	3.475±.015
45	3/16	3 5/8	4	.210±.005	3.600±.015
46	3/16	3 3/4	4 1/8	.210±.005	3.725±.015
47	3/16	3 7/8	4 1/4	.210±.005	3.850±.015
48	3/16	4	4 3/8	.210±.005	3.975±.015
49	3/16	4 1/8	4 1/2	.210±.005	4.100±.015
50	3/16	4 1/4	4 5/8	.210±.005	4.225±.015
51	3/16	4 3/8	4 3/4	.210±.005	4.350±.015
52	3/16	4 1/2	4 7/8	.210±.005	4.475±,015
53	1/4	4 5/8	5 1/8	.275±.006	4.600±.015
54	1/4	4 3/4	5 1/4	.275±.006	4.725±.015
55	1/4	4 7/8	5 3/8	.275±.006	4.850±.015
56	1/4	5	5 1/2	.275±.006	4.975±.015
57	1/4	5 1/8	5 5/8	.275±.006	5.100±.023
58	1/4	5 1/4	5 3/4	.275.±006	5.225±.023
59	1/4	5 3/8	5 7/8	.275±.006	5.350±.023
60	1/4	5 1/2	6	.275±.006	5.475±.023
61	1/4	5 5/8	6 1/8	.275±.006	5.600±.023
62	1/4	5 3/4	6 1/4	.275±.006	5.725±.023
63	1/4	5 7/8	6 3/8	.275±.006	5.850±.023
64	1/4	6	6 1/2	.275±.006	5.975±.023
65	1/4	6 1/4	6 3/4	.275±.006	6.225±.023
66	1/4	6 1/2	7	.275±.006	6.475±.023
67	1/4	6 3/4	7 1/4	.275±.006	6.725±.023
68	1/4	7	7 1/2	.275±.006	6.975±.023
69	1/4	7 1/4	7 3/4	.275±.006	7.225±.030
70	1/4	7 1/2	8	.275±.006	7.475±.030
71	1/4	7 3/4	8 1/4	.275±.006	7.725±.030
72	1/4	8	8 1/2	.275±.006	7.975±.030
73	1/4	8 1/2	9	.275±.006	8.475±.030
74	1/4	9	9 1/2	.275±.006	8.975±.030
75	1/4	9 1/2	10	.275.±006	9.475±.030
76	1/4	10	10 1/2	.275±.006	9.975±.030
77	1/4	10 1/2	11	.275±.006	10.475±.030
78	1/4	11	11 1/2	.275±.006	10.975±.030
79	1/4	11 1/2	12	.275.±006	11.475±.035
80	1/4	12	12 1/2	.275±.006	11.975±.035
81	1/4	12 1/2	13	.275±.006	12.475±.035
82	1/4	13	13 1/2	.275±.006	12.975±.035
83	1/4	13 1/2	14	.275±.006	13.475±.035
84	1/4	14	14 1/2	.275±.006	13.975±.035
85	1/4	14 1/2	15	.275±.006	14.475±.035
86	1/4	15	15 1/2	.275.±006	14.975±.035
87	1/4	15 1/2	16	.275±.006	15.475±.035
88	1/4	4 1/2	5	.275±.006	4.475±.015

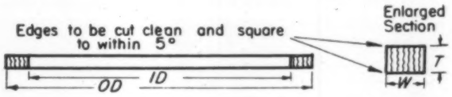
Note: See table on opposite page for information on leather back-up washers used with O-ring packings. Dash numbers correspond with AN-6227 sizes.

STANDARD SIZES FOR O RING GASKETS

Dash No.	W (Nom)	I.D. (Nom)	O.D. (Nom)	W ±.004	I.D. (Actual)
1	1/8	1 5/8	1 7/8	.139	1.609±.010
2	1/8	1 3/4	2	.139	1.734±.010
3	1/8	1 7/8	2 1/8	.139	1.859±.010
4	1/8	2	2 1/4	.139	1.984±.010
5	1/8	2 1/8	2 3/8	.139	2.109±.010
6	1/8	2 1/4	2 1/2	.139	2.234±.010
7	1/8	2 3/8	2 5/8	.139	2.359±.010
8	1/8	2 1/2	2 3/4	.139	2.484±.010
9	1/8	2 5/8	2 7/8	.139	2.609±.010
10	1/8	2 3/4	3	.139	2.734±.015
11	1/8	2 7/8	3 1/8	.139	2.859±.015
12	1/8	3	3 1/4	.139	2.984±.015
13	1/8	3 1/8	3 3/8	.139	3.109±.015
14	1/8	3 1/4	3 1/2	.139	3.234±.015
15	1/8	3 3/8	3 5/8	.139	3.359±.015
16	1/8	3 1/2	3 3/4	.139	3.484±.015
17	1/8	3 5/8	3 7/8	.139	3.609±.015
18	1/8	3 3/4	4	.139	3.734±.015
19	1/8	3 7/8	4 1/8	.139	3.859±.015
20	1/8	4	4 1/4	.139	3.984±.015
21	1/8	4 1/8	4 3/8	.139	4.109±.015
22	1/8	4 1/4	4 1/2	.139	4.234±.015
23	1/8	4 3/8	4 5/8	.139	4.359±.015
24	1/8	4 1/2	4 3/4	.139	4.484±.015
25	1/8	4 5/8	4 7/8	.139	4.609±.015
26	1/8	4 3/4	5	.139	4.734±.015
27	1/8	4 7/8	5 1/8	.139	4.859±.015
28	1/8	5	5 1/4	.139	4.984±.015
29	1/8	5 1/8	5 3/8	.139	5.109±.023
30	1/8	5 1/4	5 1/2	.139	5.234±.023
31	1/8	5 3/8	5 5/8	.139	5.359±.023
32	1/8	5 1/2	5 3/4	.139	5.484±.023
33	1/8	5 5/8	5 7/8	.139	5.609±.023
34	1/8	5 3/4	6	.139	5.734±.023
35	1/8	5 7/8	6 1/8	.139	5.859±.023
36	1/8	6	6 1/4	.139	5.984±.023
37	1/8	6 1/4	6 1/2	.139	6.234±.023
38	1/8	6 1/2	6 3/4	.139	6.484±.023
39	1/8	6 3/4	7	.139	6.734±.023
40	1/8	7	7 1/4	.139	6.984±.023
41	1/8	7 1/4	7 1/2	.139	7.234±.030
42	1/8	7 1/2	7 3/4	.139	7.484±.030
43	1/8	7 3/4	8	.139	7.734±.030
44	1/8	8	8 1/4	.139	7.984±.030
45	1/8	8 1/4	8 1/2	.139	8.234±.030
46	1/8	8 1/2	8 3/4	.139	8.484±.030
47	1/8	8 3/4	9	.139	8.734±.030
48	1/8	9	9 1/4	.139	8.984±.030
49	1/8	9 1/4	9 1/2	.139	9.234±.030
50	1/8	9 1/2	9 3/4	.139	9.484±.030
51	1/8	9 3/4	10	.139	9.734±.030
52	1/8	10	10 1/4	.139	9.984±.030

NOTES: Do not use dash numbers over 26 for pressures over 1000 psi. For pressures over 1000 psi use O-ring packings, previous table. See table on opposite page for information on leather back-up washers used with O-ring gaskets. Dash numbers correspond with AN-6230.

STANDARD SIZES FOR LEATHER BACK-UP WASHERS FOR O RING PACKINGS



Dash* No.	O.D. ±.007	I.D. (Nom.)	W ±.007	T† ±.010
1	.250	1/8	.057	.062
2	.281	5/32	.057	.062
3	.312	3/16	.057	.062
4	.344	7/32	.057	.062
5	.375	1/4	.057	.062
6	.438	5/16	.057	.062
7	.500	3/8	.057	.062
8	.562	3/8	.090	.062
9	.625	7/16	.090	.062
10	.688	1/2	.090	.062
11	.750	9/16	.090	.062
12	.812	5/8	.090	.062
13	.875	11/16	.090	.062
14	.938	3/4	.090	.062

Dash* No.	O.D. ±1/64	I.D. (Nom.)	W +.010 —.005	T† ±.010
15	1	3/4	.123	.062
16	1 1/16	13/16	.123	.062
17	1 1/8	7/8	.123	.062
18	1 3/16	15/16	.123	.062
19	1 1/4	1	.123	.062
20	1 5/16	1 1/16	.123	.062
21	1 3/8	1 1/8	.123	.062
22	1 7/16	1 3/16	.123	.062
23	1 1/2	1 1/4	.123	.062
24	1 9/16	1 5/16	.123	.062
25	1 5/8	1 3/8	.123	.062
26	1 11/16	1 7/16	.123	.062
27	1 3/4	1 1/2	.123	.062
28	1 7/8	1 1/2	.188	.094
29	2	1 5/8	.188	.094
30	2 1/8	1 3/4	.188	.094
31	2 1/4	1 7/8	.188	.094
32	2 3/8	2	.188	.094
33	2 1/2	2 1/8	.188	.094
34	2 5/8	2 1/4	.188	.094
35	2 3/4	2 3/8	.188	.094
36	2 7/8	2 1/2	.188	.094
37	3	2 5/8	.188	.094
38	3 1/8	2 3/4	.188	.094
39	3 1/4	2 7/8	.188	.094
40	3 3/8	3	.188	.094
41	3 1/2	3 1/8	.188	.094
42	3 5/8	3 1/4	.188	.094
43	3 3/4	3 3/8	.188	.094
44	3 7/8	3 1/2	.188	.094
45	4	3 5/8	.188	.094
46	4 1/8	3 3/4	.188	.094
47	4 1/4	3 7/8	.188	.094
48	4 3/8	4	.188	.094
49	4 1/2	4 1/8	.188	.094
50	4 5/8	4 1/4	.188	.094
51	4 3/4	4 3/8	.188	.094
52	4 7/8	4 1/2	.188	.094
53	5 1/8	4 5/8	.240	.125
54	5 1/4	4 3/4	.240	.125
55	5 3/8	4 7/8	.240	.125
56	5 1/2	5	.240	.125
57	5 5/8	5 1/8	.240	.125
58	5 3/4	5 1/4	.240	.125
59	5 7/8	5 3/8	.240	.125
60	6	5 1/2	.240	.125
61	6 1/8	5 5/8	.240	.125
62	6 1/4	5 3/4	.240	.125
63	6 3/8	5 7/8	.240	.125
64	6 1/2	6	.240	.125
65	6 3/4	6 1/4	.240	.125
66	7	6 1/2	.240	.125
67	7 1/4	6 3/4	.240	.125
68	7 1/2	7	.240	.125
69	7 3/4	7 1/4	.240	.125
70	8	7 1/2	.240	.125
71	8 1/4	7 3/4	.240	.125
72	8 1/2	8	.240	.125
73	9	8 1/2	.240	.125
74	9 1/2	9	.240	.125
75	10	9 1/2	.240	.125
76	10 1/2	10	.240	.125
77	11	10 1/2	.240	.125
78	11 1/2	11	.240	.125
79	12	11 1/2	.240	.125
80	12 1/2	12	.240	.125
81	13	12 1/2	.240	.125
82	13 1/2	13	.240	.125
83	14	13 1/2	.240	.125
84	14 1/2	14	.240	.125
85	15	14 1/2	.240	.125
86	15 1/2	15	.240	.125
87	16	15 1/2	.240	.125
88	5	4 1/2	.240	.125

* Dash numbers correspond with AN 6246.

† Thickness T shall not vary more than 0.010-in. between any two points on a ring.

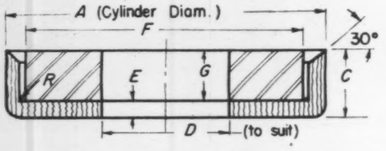
STANDARD SIZES FOR LEATHER BACK-UP WASHERS FOR O RING GASKETS

Dash No.*	O.D. ±1/64	I.D. Nom.	W +.010 —.005	T† ±.010
1	1 7/8	1 5/8	1/8	1/16
2	2	1 3/4	1/8	1/16
3	2 1/8	1 7/8	1/8	1/16
4	2 1/4	2	1/8	1/16
5	2 3/8	2 1/8	1/8	1/16
6	2 1/2	2 1/4	1/8	1/16
7	2 5/8	2 3/8	1/8	1/16
8	2 3/4	2 1/2	1/8	1/16
9	2 7/8	2 5/8	1/8	1/16
10	3	2 3/4	1/8	1/16
11	3 1/8	2 7/8	1/8	1/16
12	3 1/4	3	1/8	1/16
13	3 3/8	3 1/8	1/8	1/16
14	3 1/2	3 1/4	1/8	1/16
15	3 5/8	3 3/8	1/8	1/16
16	3 3/4	3 1/2	1/8	1/16
17	3 7/8	3 5/8	1/8	1/16
18	4	3 3/4	1/8	1/16
19	4 1/8	3 7/8	1/8	1/16
20	4 1/4	4	1/8	1/16
21	4 3/8	4 1/8	1/8	1/16
22	4 1/2	4 1/4	1/8	1/16
23	4 5/8	4 3/8	1/8	1/16
24	4 3/4	4 1/2	1/8	1/16
25	4 7/8	4 5/8	1/8	1/16
26	5	4 3/4	1/8	1/16
27	5 1/8	4 7/8	1/8	1/16
28	5 1/4	5	1/8	1/16
29	5 3/8	5 1/8	1/8	1/16
30	5 1/2	5 1/4	1/8	1/16
31	5 5/8	5 3/8	1/8	1/16
32	5 3/4	5 1/2	1/8	1/16
33	5 7/8	5 5/8	1/8	1/16
34	6	5 3/4	1/8	1/16
35	6 1/8	5 7/8	1/8	1/16
36	6 1/4	6	1/8	1/16
37	6 1/2	6 1/4	1/8	1/16
38	6 3/4	6 1/2	1/8	1/16
39	7	6 3/4	1/8	1/16
40	7 1/4	7	1/8	1/16
41	7 1/2	7 1/4	1/8	1/16
42	7 3/4	7 1/2	1/8	1/16
43	8	7 3/4	1/8	1/16
44	8 1/4	8	1/8	1/16
45	8 1/2	8 1/4	1/8	1/16
46	8 3/4	8 1/2	1/8	1/16
47	9	8 3/4	1/8	1/16
48	9 1/4	9	1/8	1/16
49	9 1/2	9 1/4	1/8	1/16
50	9 3/4	9 1/2	1/8	1/16
51	10	9 3/4	1/8	1/16
52	10 1/4	10	1/8	1/16

* Dash numbers correspond with AN-6244.

† Thickness shall not vary more than 0.010 between any two points on a ring.

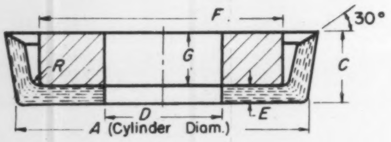
STANDARD SIZES FOR LEATHER CUP PACKINGS



Dash No.	A	C	E	F	G	R
1	7/16	1/4	1/16	9/32	3/16	1/32
2	1/2	1/4	1/16	11/32	3/16	1/32
3	9/16	1/4	1/16	13/32	3/16	1/32
4	5/8	9/32	3/32	3/8	3/16	1/32
5	11/16	9/32	3/32	7/16	3/16	1/32
6	3/4	5/16	3/32	1/2	7/32	1/32
7	13/16	5/16	3/32	9/16	7/32	1/32
8	7/8	3/8	3/32	5/8	9/32	1/32
9	15/16	3/8	3/32	11/16	9/32	1/32
10	1	1/2	1/8	21/32	3/8	1/32
11	1 1/8	1/2	1/8	25/32	3/8	1/32
12	1 1/4	1/2	1/8	29/32	3/8	1/32
13	1 3/8	1/2	1/8	1 1/32	3/8	1/32
14	1 1/2	1/2	1/8	1 5/32	3/8	1/32
15	1 5/8	1/2	1/8	1 9/32	3/8	1/32
16	1 3/4	1/2	1/8	1 13/32	3/8	1/32
17	1 7/8	1/2	1/8	1 17/32	3/8	1/32
18	2	1/2	1/8	1 21/32	3/8	1/32
19	2 1/8	1/2	1/8	1 25/32	3/8	1/32
20	2 1/4	1/2	1/8	1 29/32	3/8	1/32
21	2 3/8	1/2	1/8	2 1/32	3/8	1/32
22	2 1/2	1/2	1/8	2 5/32	3/8	1/32
23	2 5/8	1/2	1/8	2 9/32	3/8	1/32
24	2 3/4	1/2	1/8	2 13/32	3/8	1/32
25	2 7/8	1/2	1/8	2 17/32	3/8	1/32
26	3	5/8	5/32	2 9/16	15/32	1/32
27	3 1/8	5/8	5/32	2 11/16	15/32	1/32
28	3 1/4	5/8	5/32	2 13/16	15/32	1/32
29	3 3/8	5/8	5/32	2 15/16	15/32	1/32
30	3 1/2	5/8	5/32	3 1/16	15/32	1/16
31	3 5/8	5/8	5/32	3 3/16	15/32	1/16
32	3 3/4	5/8	5/32	3 5/16	15/32	1/16
33	3 7/8	5/8	5/32	3 7/16	15/32	1/16
34	4	5/8	5/32	3 9/16	15/32	1/16
35	4 1/4	5/8	5/32	3 13/16	15/32	1/16
36	4 1/2	5/8	5/32	4 1/16	15/32	1/16
37	4 3/4	5/8	5/32	4 5/16	15/32	1/16
38	5	3/4	3/16	4 1/2	9/16	1/16
39	5 1/4	3/4	3/16	4 3/4	9/16	1/16
40	5 1/2	3/4	3/16	5	9/16	1/8
41	5 3/4	3/4	3/16	5 1/4	9/16	1/8
42	6	3/4	3/16	5 1/2	9/16	1/8
43	6 1/4	3/4	3/16	5 3/4	9/16	1/8
44	6 1/2	3/4	3/16	6	9/16	1/8
45	6 3/4	3/4	3/16	6 1/4	9/16	1/8
46	7	3/4	3/16	6 1/2	9/16	1/8
47	7 1/4	3/4	3/16	6 3/4	9/16	1/8
48	7 1/2	3/4	3/16	7	9/16	1/8
49	7 3/4	3/4	3/16	7 1/4	9/16	1/8
50	8	1	3/16	7 1/2	13/16	1/8
51	8 1/2	1	3/16	8	13/16	1/8
52	9	1	3/16	8 1/2	13/16	1/8
53	9 1/2	1	3/16	9	13/16	1/8
54	10	1	3/16	9 1/2	13/16	1/8
55	10 1/2	1 1/4	3/16	10	1 1/16	1/8
56	11	1 1/4	3/16	10 1/2	1 1/16	1/8
57	11 1/2	1 1/4	3/16	11	1 1/16	1/8
58	12	1 1/4	3/16	11 1/2	1 1/16	1/8

NOTE: The above are standard commercial sizes recommended for new designs. Other sizes for equipment already in use are available.

STANDARD SIZES FOR FABRICATED CUP PACKINGS



Dash No.*	A	C	D†	E	F	R
10	1	1/2	3/8	1/8	.708	1/32
11	1 1/8	1/2	3/8	1/8	.835	1/32
12	1 1/4	1/2	3/8	1/8	.961	1/32
13	1 3/8	1/2	3/8	1/8	1.085	1/32
14	1 1/2	1/2	1/2	1/8	1.203	1/32
15	1 5/8	1/2	1/2	1/8	1.332	1/32
16	1 3/4	1/2	1/2	1/8	1.459	1/32
17	1 7/8	1/2	1/2	1/8	1.584	1/32
18	2	1/2	1/2	1/8	1.709	1/32
19	2 1/8	1/2	1/2	1/8	1.832	1/32
20	2 1/4	1/2	1/2	1/8	1.959	1/32
21	2 3/8	1/2	1/2	1/8	2.082	1/32
22	2 1/2	1/2	1/2	1/8	2.203	1/32
23	2 5/8	1/2	1/2	1/8	2.334	1/32
24	2 3/4	1/2	1/2	1/8	2.448	1/32
25	2 7/8	1/2	1/2	1/8	2.585	1/32
26	3	5/8	3/4	5/32	2.641	1/32
27	3 1/8	5/8	3/4	5/32	2.752	1/32
28	3 1/4	5/8	3/4	5/32	2.897	1/32
29	3 3/8	5/8	3/4	5/32	3.022	1/32
30	3 1/2	5/8	3/4	5/32	3.140	1/16
31	3 5/8	5/8	3/4	5/32	3.267	1/16
32	3 3/4	5/8	3/4	5/32	3.390	1/16
33	3 7/8	5/8	3/4	5/32	3.516	1/16
34	4	5/8	3/4	5/32	3.643	1/16
35	4 1/4	5/8	3/4	5/32	3.891	1/16
36	4 1/2	5/8	1	5/32	4.155	1/16
37	4 3/4	5/8	1	5/32	4.393	1/16
38	5	3/4	1 1/2	3/16	4.579	1/16
39	5 1/4	3/4	1 1/2	3/16	4.842	1/16
40	5 1/2	3/4	1 1/2	3/16	5.074	1/8
41	5 3/4	3/4	1 1/2	3/16	5.332	1/8
42	6	3/4	1 1/2	3/16	5.579	1/8
43	6 1/4	3/4	1 1/2	3/16	5.826	1/8
44	6 1/2	3/4	2	3/16	6.073	1/8
45	6 3/4	3/4	2	3/16	6.325	1/8
46	7	3/4	2	3/16	6.585	1/8
47	7 1/4	3/4	2	3/16	6.821	1/8
48	7 1/2	3/4	2 1/2	3/16	7.084	1/8
49	7 3/4	3/4	2 1/2	3/16	7.331	1/8
50	8	1	3 3/4	1/4	7.467	1/8
51	8 1/2	1	3 3/4	1/4	7.959	1/8
52	9	1	4	1/4	8.459	1/8
53	9 1/2	1	4	1/4	8.953	1/8
54	10	1 1/4	5	1/4	9.445	1/8
55	10 1/2	1 1/4	5	1/4	9.943	1/8
56	11	1 1/4	5	1/4	10.441	1/8
57	11 1/2	1 1/4	5	1/4	10.941	1/8
58	12	1 1/4	5	1/4	11.440	1/8

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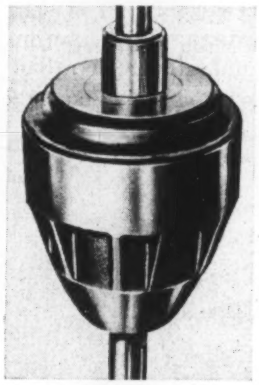
* The above are standard commercial sizes recommended for new designs. Other sizes for equipment already in use are available. For sizes smaller than dash 10, refer to previous table, showing leather cup standards.

† Hole size specified is minimum only and can be furnished larger. R is radius of packing and inside follower plate. All cups will have flared walls so that lip diameter will actually be oversize to cylinder bore.

NEW PARTS AND MATERIALS

For additional information on these new developments see Page 173

Interrupted-Rotation Drive

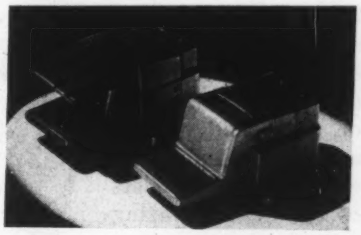


Constant speed input is converted and reduced by Augur Movement power transmission to produce quick reversing action that interrupts rotation of output shaft every 45 degrees of travel. This action is short back-up motion that occurs approximately eight times in one complete revolution of output shaft. Transmission is smooth and continuous, and reversing action does not develop torque counter to direction of rotation.

Originally designed as machine tool accessory to perform honing and lapping operations, unit is adaptable as either power transmission or agitator. It is recommended as power transmission for tumbling barrels, screw feed stokers, cement mixers, washing machine agitators, rotating displays, deep well drills, and similar equipment. It can be used for agitation in plating solutions; mixing paints, varnish and other chemical compounds; and in shakeout screens and hopper feeds. Other applications include buffing and polishing, pipe threading, valve grinding and floor sanding machines. Three standard sizes are available, and special sizes can be supplied if desired. Manufacturer: Metal Seal & Products Inc., 21855 St. Clair Ave., Euclid 17, O.

For additional information circle MD 1 on Page 173

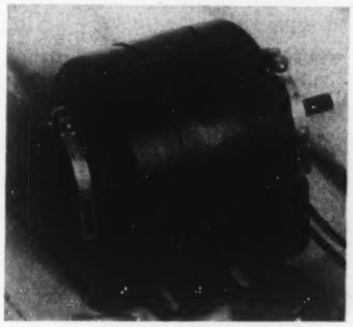
Disk Type Air Control Valve



Pilot controlled and piston operated, model NFS packless foot-operated disk-type valve is designed to direct compressed air alternately to two pressure ports for operation of double-acting air cylinder. Sliding self-lapping main valve disk is shifted by reciprocating light metal piston which is moved by alternately admitting line pressure to one end and venting other. Although constructed to withstand full weight of operator, foot pedal actually operates only small pilot valve and moves less than ¾-in. under slight foot pressure for quick, easy action. Valve is available in ½ and ¾-in. sizes for air pressures from 25 to 150 psi. Safety guard, which extends over pedal and minimizes possibility of unintentional operation, is optional. Manufacturer: Hannifin Corp., 1116 S. Kilbourn Ave., Chicago 24, Ill.

For additional information circle MD 2 on Page 173

Lifetime Lubricated Motors



Available in frame sizes 11 and 21, type KSP motors can be used to drive exhaust and cooling fans, evaporative and condensing coolers, unit and space heaters as well as small pumps, agitators and blowers. They can be furnished in open or totally enclosed construction with ratings from 1/40 to 1/12-hp at 115 or 230 v, 60 cycles, 1050 or 1550 rpm.

Lubrication system provides constant flow of oil from large reservoir to bearing surfaces regardless of position of motor. Oil-saturated packing continuously feeds bearing; no additional lubricant is required. Features include unit-bearing construction in shaft end for greater strength on direct-connected loads, treated stator windings of Formex insulated wire, and vibration absorbing resilient end rings which are resistant to oil and aging. Mounting arrangements include end ring, resilient cradle base and band mounting; motors can be furnished with four tapped holes on shaft end for end mounting. Manufacturer: General Electric Co., Schenectady 5, N. Y.

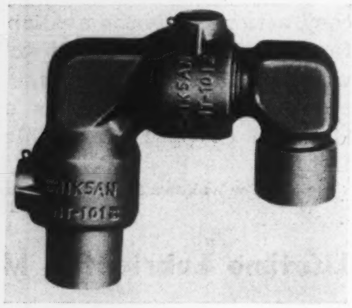
For additional information circle MD 3 on Page 173

V-Type Packing

Usable for rams with diameters over 20 in., Vee-Dam* fabric-reinforced packing is supplied in ⅝, ¾, ⅞ and 1-in. sections. Fully flexible material prevents lateral passage of liquid as well as normal labyrinth flow. Precision square-cut butt joints permit ring to be cut full inch longer than actual circumference on size no larger than 4 ft, and still be installed with ease. This helps packing ring to expand to breach over-width gland space, as well as provide excess of length not likely to be exceeded by shrinkage. Where shrinkage might cause separation of joints, design will prevent labyrinth flow. Manufacturer: Linear Inc., Philadelphia 35, Pa.

For additional information circle MD 4 on Page 173

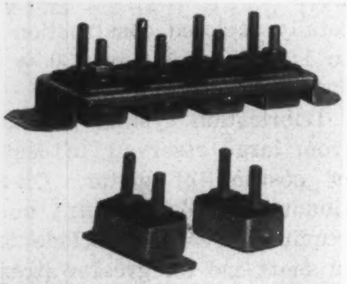
High-Temperature Swivel Joint



Made in eight styles for 360-degree turning in one, two and three planes, this swivel joint with metallic seal will operate at temperatures to 600 F and maximum working pressure of 300 psi. Metallic seal is fully effective in both constant and intermittent service. Easy turning takes place on stainless steel balls which help absorb radial and thrust loads. Joint can be installed in any desired sequence and is supplied in ¾, 1, 1¼, 1½ and 2-in. sizes with either threaded or flanged ends. Manufacturer: Chiksan Co., Brea, Calif.

For additional information circle MD 5 on Page 173

Automatic Reset Circuit Breakers



Previously limited to automotive applications, Fasco line of automatic reset circuit breakers has been expanded to include types for use on aircraft, battery chargers, electroplating circuits and other 6, 12 and 24-v operations. Available in 8, 10, 15, 20, 25 and 30-amp ratings, they can be supplied singly or in multiples of two, three or four in Snap-Mount brackets. Individual circuit breakers can be furnished with their own mounting straps.

When protected circuit is overloaded, bimetal blade snaps open to open circuit; when blade cools, it snaps back to close circuit. This off-and-on cycle continues until trouble is corrected. Manufacturer: Fasco Industries Inc., 350 North Union St., Rochester 2, N. Y.

For additional information circle MD 6 on Page 173

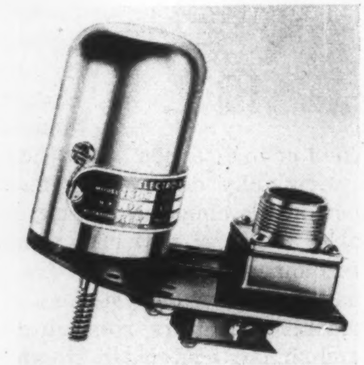
Small Variable-Speed Transmission

Suitable for use in instruments, recorders, timers, office machinery, light conveyors and similar equipment, model 10 small size variable speed transmission delivers all speeds in range with great accuracy of speed holding and reset. It is available with lever type control which can be connected to mechanical hydraulic, electric and pneumatic automatic control devices or can be furnished with micrometer control for extremely fine adjustment.

When driven at 2700 rpm, transmission delivers speeds from 1800 to 0 rpm; and at 1800 rpm input, it gives speeds from 1200 to 0 rpm with torque of 50 oz-in. Built-in reduction gearboxes with ratios from 5:1 to 1000:1 are available for use with drive to deliver torque up to 250 lb-in. Transmission is self-lubricated and has sealed bearings which permit mounting in any position. Manufacturer: Graham Transmissions Inc., 3754 N. Holton St., Milwaukee 12, Wis.

For additional information circle MD 7 on Page 173

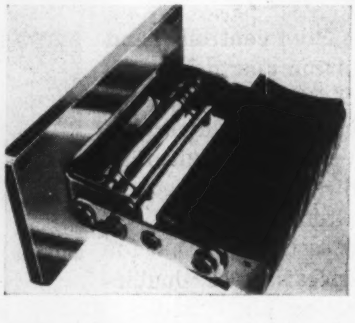
Miniature D-C Motor



Designed to keep weight and size to a minimum, model 1305 1/100-hp d-c motor can be used for any type of application requiring linear or rotary motion. Running torque is listed at 1 oz-in. at 10,000 rpm on 28 volts d-c, but motor is adaptable to other torque and speed requirements and to specific plans and housings. Brush and brush holder are compact in size and motor weighs 15 oz. Dimensions, excluding worm gear, are 2.875 x 1.75 in. and mounting plate measures 2.7 x 3.4 in. Manufacturer: Electro-Aire Inc., 11439 Vanowen St., N. Hollywood, Calif.

For additional information circle MD 8 on Page 173

Journal Box Lubricator

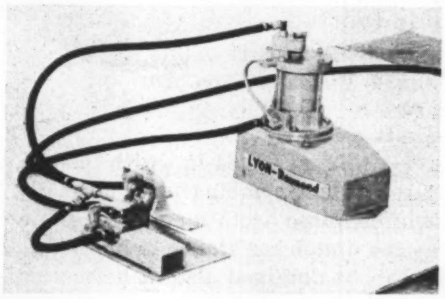


Available in models for practically all styles of journal boxes, this lubricator is designed for journals on overhead cranes and similar industrial equipment. It consists of special nonglazing felt wicks attached to holder which holds wicks in place with correct pressure against axle to provide full and constant lubrication to bearings and thrust flanges at all times. Complete assembly fits into journal box and can be installed in three simple steps. Only service required is periodic checking and filling of oil reservoir. Felt wicks have long life and are easily replaced with sets matched at factory, impregnated with high quality oil and sealed in oilproof container. Manufacturer: Miller-Felpax Corp., Dept. I., Winona, Minn.

For additional information circle MD 9 on Page 173

Air-Actuated Hydraulic Pump

Capable of pumping oil at 1 to 1½-gpm rate, this continuous-acting pump develops a working oil pressure of 1000 psi from 90-psi air pressure. Units with higher working pressures are available also. Reciprocating valve alternately diverts air pressure from one side of air piston to other. Small hydraulic piston directly connected to air piston pumps oil under high pressure. Pump is equipped with built-in release valve to permit pressurized oil in hydraulic cylinder to return to reservoir by gravity. Single three-position four-way foot valve operates release and controls pumping action. Pump is designed for use with hydraulic elevating tables, positioners and strip and sheet feeding tables. Manufacturer: LYON-Raymond Corp., 7259 Madison St., Greene, N. Y.



For additional information circle MD 10 on Page 173

Pillow Block

Designed especially to handle heavy loads over long periods of service, these normal and heavy-duty spherical roller bearing pillow blocks are supplied in bore sizes ranging from 2-7/16 to approximately 8 in. Built for either straight shaft or adapter type mounting, they are self-aligning and incorporate either felt or triple metallic labyrinth seals. Manufacturer: Fafnir Bearing Co., New Britain, Conn.

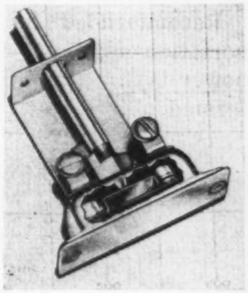
For additional information circle MD 11 on Page 173

Resistor Coil

Possibility of porcelain breakage is minimized in Expand-ohm Edge-wound resistor by core expansion feature and stiffening ribs on core bar which confine flexing to points where porcelain is relieved. Among applications of unit are controlling speed or reducing starting voltages for a-c and d-c motors. Units can be grouped in parallel to handle increasing currents. They are available in capacities ranging from 11 to 85 amps in small increments and will carry rated current continuously without exceeding 375 C temperature rise. Standard mounting frame is mill type construction which can be enclosed readily by perforated metal screen when required. Both clamp and brazed type terminals are available. Manufacturer: Euclid Electric & Mfg. Co., Madison, O.

For additional information circle MD 12 on Page 173

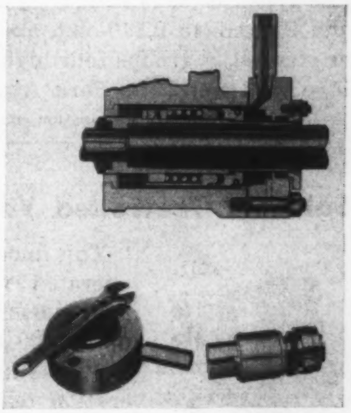
Postive-Operating Bimetal Thermostat



Positive-operating bimental type R low-voltage circuit control thermostat is designed for use in appliances and for industrial and electronic applications requiring precise temperature control. It is available in manually adjustable or preset nonadjustable types. Both can be obtained with wide variety of terminal arrangements and in many operating ranges up to 600 F. Containing electrically independent bimetal strip that eliminates artificial cycling, thermostat responds only to temperature changes in controlled device or surrounding air. Manufacturer: Stevens Mfg. Co., Mansfield, O.

For additional information circle MD 13 on Page 173

High-Pressure Mechanical Seals



These mechanical seals can effectively replace conventional packing in refining, process and chemical industry pumps and in pipe line installations. They are easily installed and require no adjustment during or after installation. Type U balanced high-pressure single seal is intended for use on shafts of from 1⅛ to 5⅞-in. diameter and can be adapted to larger shafts if necessary. When constructed of corrosion and heat-resistant materials, this type is suitable for service where high temperatures and corrosive liquids are handled at high pressures.

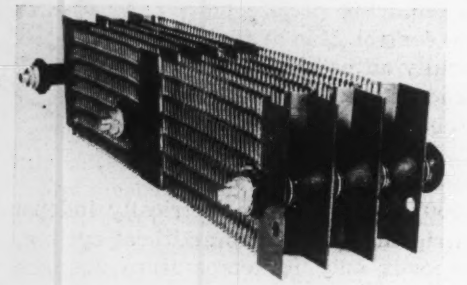
Simple and inexpensive, type L low-pressure single seal is designed for small pumps handling cold water or bulk station products where temperatures do not exceed 110 F and pressures do not go above 50 psi. It is suitable for pumps where shaft diameters do not exceed 2 in.

Type B oil-lubricated double seal is intended for high pressures and cold service where pumped liquids have little lubricating value. Applications include high pressure pipe lines where products such as butane and propane are pumped. Two-compartment oil tank assembly included with seal supplies oil to compensate for lubrication leakage. Manufacturer: Byron Jackson Co., Pump Div., Terminal Annex Box 2017, Los Angeles 54, Calif.

For additional information circle MD 14 on Page 173

High-Current Power Type Resistor

Recommended for industrial, marine and transportation applications, this Multipath high-current power type resistor utilizes element made of slit and formed alloy sheet. This construction increases surface area and heat dissipation; and since mesh is made of same material as support, there is no mechanical or electrical break. Resistance of supporting element is low, and heat developed in it is only one-fifth to one-ninth that generated in mesh. Units of this type can be obtained with ratings from 4.35 ohms and 22 amp to 0.340-ohm and 80 amp for use singly or stacked in groups four high. Manufacturer: Exmet Electrical Corp., 59 Park Ave., New York 16, N. Y.



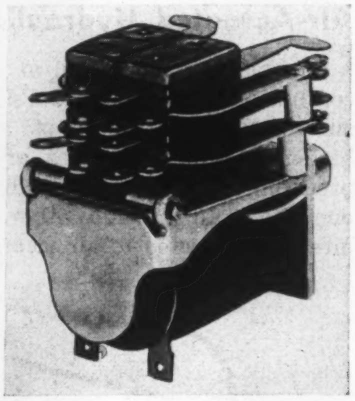
For additional information circle MD 15 on Page 173

Solenoid-Controlled Valve

This model 1044 four-way pilot operated valve can be operated continuously at any cycling speed up to 600 cycles per minute. It is available in two types, one for operation on line pressures from 0 to 50 psi, the other for 30 to 150 psi. Two main valve members are disposed in vertical alignment with two parallel bores in valve body and move up and down simultaneously to open and close their respective inlet and exhaust ports. When one valve is open to inlet and closed to exhaust, other is closed to inlet and open to exhaust. With solenoid de-energized, valve members are held up by combination of light stainless steel springs and fluid pressure; when solenoid is energized to actuate integral three-way pilot valve, they are moved down by pressure applied to pistons. Cast bronze bodies have screwed pipe connections tapped for ¼, ⅜, ½ or ¾-in. I.P.S. Manufacturer: Crescent Valve Co., 6073 State St., Huntington Park, Calif.

For additional information circle MD 16 on Page 173

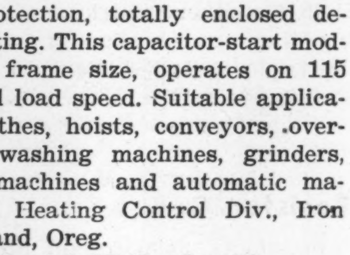
Miniature Control Relay



This type TKL miniature relay is available in contact combinations up to four-pole double-throw with either silver or palladium contacts. Contacts are rated 1 amp at 115 volts, a-c or 1 amp at 32-volts, d-c noninductive. Coils can be supplied for any operating voltage up to 115 volts, d-c. Relay measures 1-19/32 x 61/64-in. with height, varying according to contact combinations, normally 1-17/32-in. Coil is of cellulose acetate sealed construction that gives relay maximum resistance to humidity and moisture. Unit can be obtained also in hermetically sealed enclosures. Manufacturer: American Relay & Controls Inc., Chicago 44, Ill.

For additional information circle MD 17 on Page 173

Totally-Enclosed Single-Phase Motor



Incorporating Reverswitch motor reversing switch, this single-phase 1/3-hp motor starts in either direction, reverses instantly and can be allowed to stop normally or stopped immediately at flip of built-in control switch. It features shielded ball bearings, automatic overload protection, totally enclosed design and resilient mounting. This capacitor-start model has NEMA No. 56 frame size, operates on 115 v and has 1725-rpm full load speed. Suitable applications include use of lathes, hoists, conveyors, overhead doors, displays, washing machines, grinders, power rollers, testing machines and automatic machinery. Manufacturer: Heating Control Div., Iron Fireman Mfg. Co., Portland, Oreg.

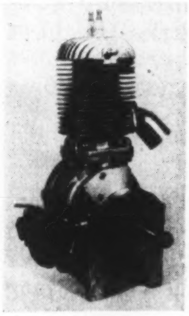
For additional information circle MD 18 on Page 173

Oil-Resistant Air Hose

Three-ply fabric reinforced type 22 air hose is improved by use of oilproof rubber compounds throughout. Hose can be used for variety of applications in addition to its primary use as air hose, including handling of petroleum solvents and lubricating oils. Smooth red finish cover resists weathering and sun checking, and tube will not flake off to plug attachments or tools. Strong adhesion of cover to carcass enables hose to withstand repeated bending and flexing with little danger of separation. Hose is supplied in 1/4, 5/16 and 3/8-in. sizes. Outside diameters are 1/2, 9/16 and 21/32-in., respectively, and weight per 100 ft is 10.3, 12.2 and 15.1 lb. The two smaller sizes withstand 150 psi working pressure and the larger withstands 125 psi. Manufacturer: B. F. Goodrich Co., Akron, O.

For additional information circle MD 19 on Page 173

Lightweight Gasoline Engine



Having 2-in. bore and 2½-in. stroke, Servi-Cycle single cylinder two-cycle gasoline engine develops 3½ hp at 3800 rpm and has maximum torque of 61 lb-in. at 2500 rpm. Through use of aluminum die-cast crankcase, connecting rod and cylinder with cast-in cast iron sleeve, engine weight, less magneto, is only 12.7 lb. Piston is permanent-mold aluminum alloy, having two compression rings. Forged steel balanced crankshaft is supported by two large tapered roller bearings. Fuel is admitted through die-cast rotary valve from Tillotson type M T carburetor. Manufacturer: Simplex Mfg. Corp., New Orleans 19, La.

For additional information circle MD 20 on Page 173

Fractional-Horsepower V-Belt

This fractional horsepower V-belt is designed for exacting conditions in air moving field such as in attic fans, furnace fans and air conditioning units where smooth vibrationless performance is necessary. Available in wide range of sizes, it has uniform cross-section and is noiseless. Manufacturer: Browning Mfg. Co., Maysville, Ky.

For additional information circle MD 21 on Page 173

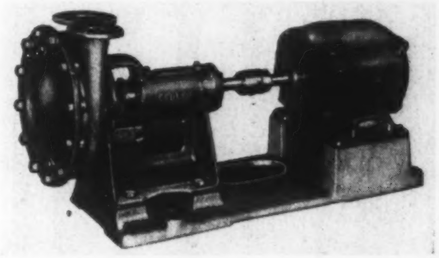
Synthetic Rubber Compound

Molded, extruded and die-cut rubber parts fabricated from Stallite 863 rubber compound will withstand action of wide range of reagents, acids, alkalies and heat. Material has high flex and abrasion resistance, and its dielectric properties make it suitable for many applications in electrical equipment. Parts fabricated from compound can have durometer hardness ranging from 40 to 80, tensile strength up to 2000 psi and elongation up to 500 per cent. Applications include seals, stoppers, gaskets, washers, tubing, rubber stamp blanks and other parts that come into contact with chemicals or corrosive atmospheres. Manufacturer: Stalwart Rubber Co., 180 Northfield Rd., Bedford, O.

For additional information circle MD 22 on Page 173

Stainless Steel Pumps

Designed for handling corrosive liquids in process and other industries, Fig. 3705 stainless steel centrifugal pumps are built in eight sizes with capacities up to 750 gpm and heads up to 180 ft. Semiopen type impeller is statically and hydraulically balanced. Pump is regularly supplied in No. 316 or FA 20 stainless steel, but can be furnished in other metals or alloys to suit conditions of service. Manufacturer: Goulds Pumps Inc., Seneca Falls, N. Y.



For additional information circle MD 23 on Page 173

Variable-Speed Motor

Recommended for agitator drives and for building into machines, Speed-Trol vertical face-mounted motor is equipped with easy-to-read speed indicator. Use of indicator facilitates infinite speed adjustment either through fingertip control on motor or through mechanical, electrical or lever type controls. Motor is Klosd-Tite type built integrally with pulleys, shafts and belts. Unit can be obtained also with flange mounted construction. Manufacturer: Sterling Electric Motors Inc., 5401 Anaheim—Telegraph Rd., Los Angeles 22, Calif.

For additional information circle MD 24 on Page 173

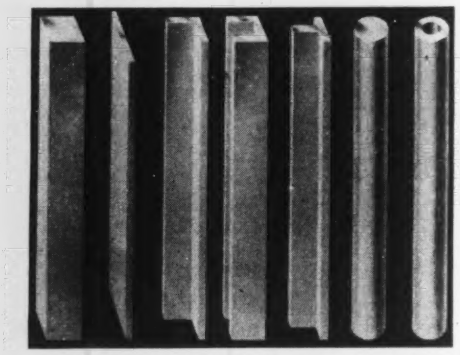
Flywheel Loom Motor

Totally-enclosed, integrally-mounted flywheel of this line of electric loom motors minimizes variations in speed and current, thus reducing power consumption and allowing increased loom speed without increasing horsepower. Furnished in ratings from ¾ to 2 hp, 1800 to 1200 rpm, motors are of totally-enclosed construction. Integrally-cast rotor fan distributes motor heat evenly, and oil fittings are conveniently located to facilitate lubrication. Manufacturer: General Electric Co., Schenectady 5, N. Y.

For additional information circle MD 25 on Page 173

Iron Castings

Cast of Meehanite, standard shapes and forms are 12 in. long and can be obtained in sizes from ¼ to 12 in. for squares and flats; ¼ to 18 in. for rounds and bushings; and 1 to 18 in. for angles, channels and tees, with ⅛-in. allowance on all dimensions for finishing. Castings have tensile strengths of between 15 and 25 tons per square inch combined with fast machinability and no porosity. Manufacturer: Motors & Metals Inc., 220-4 W. 42nd St., New York 18, N. Y.



For additional information circle MD 26 on Page 173

Terminal Block

Made of molded Melamine for high dielectric strength, these sectional terminal blocks can be assembled into strips of any length from one to 75 pairs. Units are twisted into keystone type mounting channel, and intermediate units can be removed without disconnecting other units. End clamps are available in both spring type requiring no drilling and angle-bracket type held in position by mounting screws. Terminals can be obtained in 25 and 50-amp sizes for use up to 600 volts ac or dc. Conductors as large as No. 10 solid copper wire can be used with 25-amp blocks and conductors as large as No. 4 stranded cable with 50-amp blocks. Manufacturer: Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

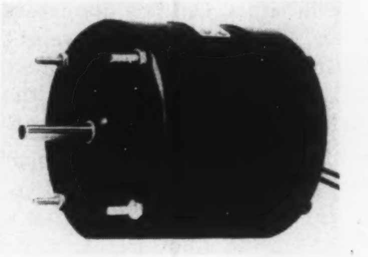
For additional information circle MD 27 on Page 173

Free-Machining Steel

Tests indicate that Ledloy leaded open hearth free-machining steel machines from 30 to 50 per cent faster than AISI B1113 steel. Cutting tools used on this material last considerably longer between grindings, and finished product is smoother than on comparable steels, Leaded steel has good strength and ductility, provides good base for plating and will carburize with sound cross section. Manufacturer: Joseph T. Ryerson & Son Inc., P. O. Box 8000-A, Chicago 80, Ill.

For additional information circle MD 28 on Page 173

Three-Speed A-C Motor



Manufactured in six, four and two-pole types ranging from 1/40 to 1/8-hp, Tri-Motor three-speed a-c motor incorporates built-in speed control to reduce materials and assembly costs. Unitized construction with no external choke coil is said to assure quiet operation. Manufacturer: Marco Industries Inc., 1611 Terrace Blvd., Depew, N. Y.

For additional information circle MD 29 on Page 173

Low-Temperature Alloy

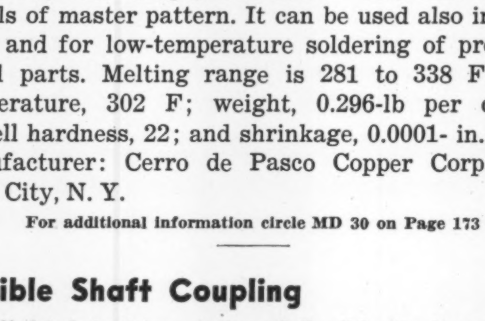
A noneutectic alloy of bismuth and tin, Cerrocast has reasonable hardness, negligible shrinkage and extensive melting range. It is especially suitable for use in precision casting where, because of its long melting range, it can be coined readily to reproduce accurately the shape, dimensions and fine surface details of master pattern. It can be used also in spray guns and for low-temperature soldering of pretinned metal parts. Melting range is 281 to 338 F; yield temperature, 302 F; weight, 0.296-lb per cu in.; Brinell hardness, 22; and shrinkage, 0.0001- in. per in. Manufacturer: Cerro de Pasco Copper Corp., New York City, N. Y.

For additional information circle MD 30 on Page 173

Flexible Shaft Coupling

Of light-duty type, series of flexible shaft couplings permits remote control of equipment, being particularly adaptable to use in electronics and instrumentation fields. They can be used for knob controls of tuners, band switches, small valves, gears and pulleys and as driving medium for light transmission systems where connected shafts are misaligned. Line of standard fittings is available with threaded, socketed, slotted, flatted, splined and plain terminals for wide range of applications. Manufacturer: Elliott Mfg. Co., 217 Prospect Ave., Binghamton, N. Y.

For additional information circle MD 31 on Page 173



JOHNSON BRONZE

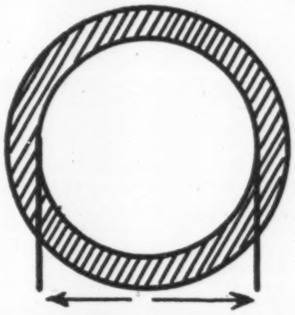
SLEEVE BEARING DATA

CAST BRONZE

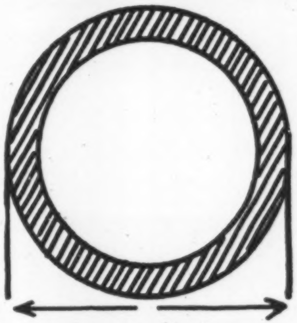
JOHNSON BRONZE

SLEEVE BEARING DATA

Stock Sizes or Specials?



55 Inside Diameters



55 Outside Diameters

46 Lengths

THE trend, in recent years, among leading designers of machinery and equipment is to use standard stock parts rather than specials wherever possible. And there is sound reasoning behind this move, particularly in cast bronze sleeve bearings.

Naturally in some instances it is essential to design and produce a special bearing for a specific application. Such factors as flanges, wall thickness, taper, special alloys and other characteristics that cannot be provided for in stock bearings can only be secured through special manufacturing operations. This often necessitates special patterns, tools, dies or other equipment not included in the cost of stock items. With the exception of long production runs of one size, special bearings are more costly than stock items.

The factors that favor the designer in working to standard stock bearings are many. First, he has an unusually large range of sizes from which to make his choice. At the present we list over 850, comprised of 55 inside diameters, ranging from ¼ inch to 4¼; 55 outside diameters ⅜ to 4½; 46 lengths ranging from ¾ to 9¾. Thus it is possible to secure practically any size combination desired.

Standard stock bearings are cast in what is usually referred to as a general purpose alloy, providing better than average physical properties assuring long life and excellent performance. Oil grooves, slots, or holes are easily, quickly and economically added. Standard tolerances, as listed below, can easily be altered where closer precision is required or where greater clearance is necessary.

Stock bearings are lower in cost, too, a very important feature in today's market. By making long runs of each size we are able to secure a low unit cost, which saving is passed on to the user. There is never any charge for patterns or tools. Complete stocks of all sizes are always maintained providing immediate delivery in any quantity. This eliminates the necessity for maintaining extensive inventory yet provides immediate service.

Engineering Service

It has always been the policy of the Johnson Bronze Company to work with customers in order to give them the greatest value for their money when purchasing bearings. In many cases we have found that a very slight change in bearing specifications or a slight alteration of a stock bearing will give the user the full benefits of this stock bearing service. We can also help you determine the correct type of bearing for each application. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts, free from prejudice. Why not take full advantage of this free service?

JOHNSON
BRONZE

CATALOGUE *—Lists and describes the most complete stock bronze sleeve bearing service on the market. Its more than 80 pages are filled with helpful bearing data. Write for free copy.*

Tolerances

Years of constant study of the bearing requirements of machinery builders have not only guided the selection of the sizes to stock as standard but have also governed the decision on the proper tolerances to standardize on. We find the following most acceptable:

Outside Diam. up to 3"....plus .002" to .003"
Outside Diam. above 3"...plus .003" to .005"

All Inside Diameters.......plus or minus .001"
All Lengths.............plus or minus .005"

●

This bearing data sheet is but one of a series You can get the complete set by writing to—

Johnson Bronze

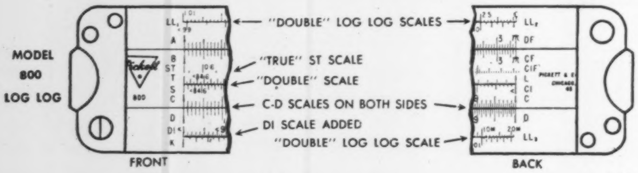
SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

ENGINEERING DEPARTMENT EQUIPMENT

For additional information on this new equipment see Page 173

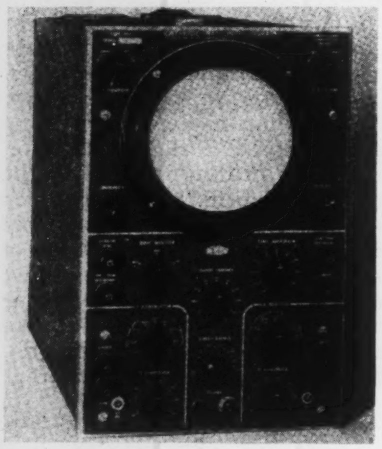
Log Log Slide Rule

Utilizing double scales, the 10-in. model 800 log log slide rule places six log log mated scales together with numbers and their reciprocals back-to-back for accurate, easy reading. C scales are placed on both sides and DI scale is included. True ST scale gives average of S and T scales for angles up to 5.73 degrees. All scales are decimally divided, co-ordinate front and back, are full unit length and refer to C and D scales. Having distortion-free magnesium alloy body, rule measures 12⅛ x 1½ x 5/32-in. Manufacturer: Pickett & Eckel Inc. 1111 S. Fremont Ave., Alhambra, Calif.



For additional information circle MD 32 on Page 173

Cathode-Ray Oscillograph



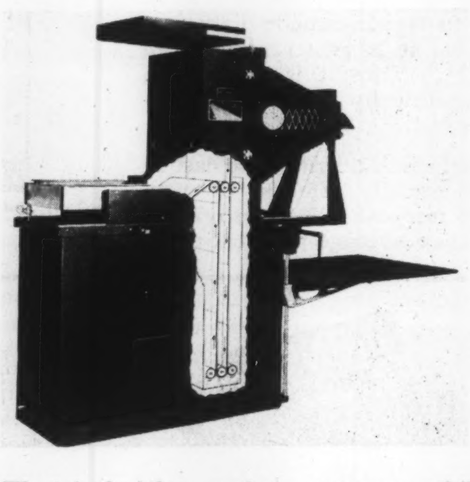
Recurrent and driven sweeps variable from 2 to 30,000 cycles per second are indicated by types 304 and 304-H cathode-ray oscillographs which supersede models for type 208-B. Extremely slow sweeps of 10 seconds or more are obtained by connection of external capacitors between X-input terminals on front panel. Stable high-gain a-c and d-c amplifiers are provided for both X and Y axes. Circuit design assures instantaneous recovery from signal overload even at high gain. Vertical deflections on these instruments can be expanded to four times full-screen diameter; horizontal deflections, to five times full-screen diameter. Positioning controls have sufficient range that any portion of fully expanded pattern can be centered on screen, with no on-screen distortion present. Stabilized synchronization of pattern is maintained by sync-limiting circuit, so sweep length and synchronization are unaffected by variations in signal voltage level.

In type 304, the cathode-ray tube is operated at overall accelerating potential of 1780 v. In type 304-H, additional intensifier power supply increases this potential to 3000 v. Higher accelerating potential of latter type facilitates use of long-persistence screens so that fullest possible advantage can be taken of slow recurrent sweeps, high-speed driven sweeps, and d-c amplifiers of instrument. Writing rates as high as 2.8 in. per microsecond can be photographed from screen of type 304-H using Du Mont camera. Manufacturer: Allen B. Du Mont Laboratories Inc., Instrument Div., 1000 Main Ave., Clifton, N. J.

For additional information circle MD 33 on Page 173

Photocopy Machine

Copies of anything written, printed, drawn, typed or photographed in reduced or enlarged size at rate of three 18 x 24-in. photocopies per minute can be made with Foto-Flow model C semiautomatic photocopying machine. No darkroom is required as paper rolls can be changed in daylight without danger of exposure. Timing and print transport are automatic; operator merely sets clock for required exposure time. Electrical relay makes exposure while mechanical counter records number of copies made.



Automatic conveyor feeds prints through developing tank into hypo tray, making possible controlled 45-second developing cycle. Machine accepts materials up to 36 x 48 in. which can be reduced in one exposure to 18 x 24 in. Copy 9 x 12 in. in size can be enlarged to 18 x 24 in. in one exposure. Machine

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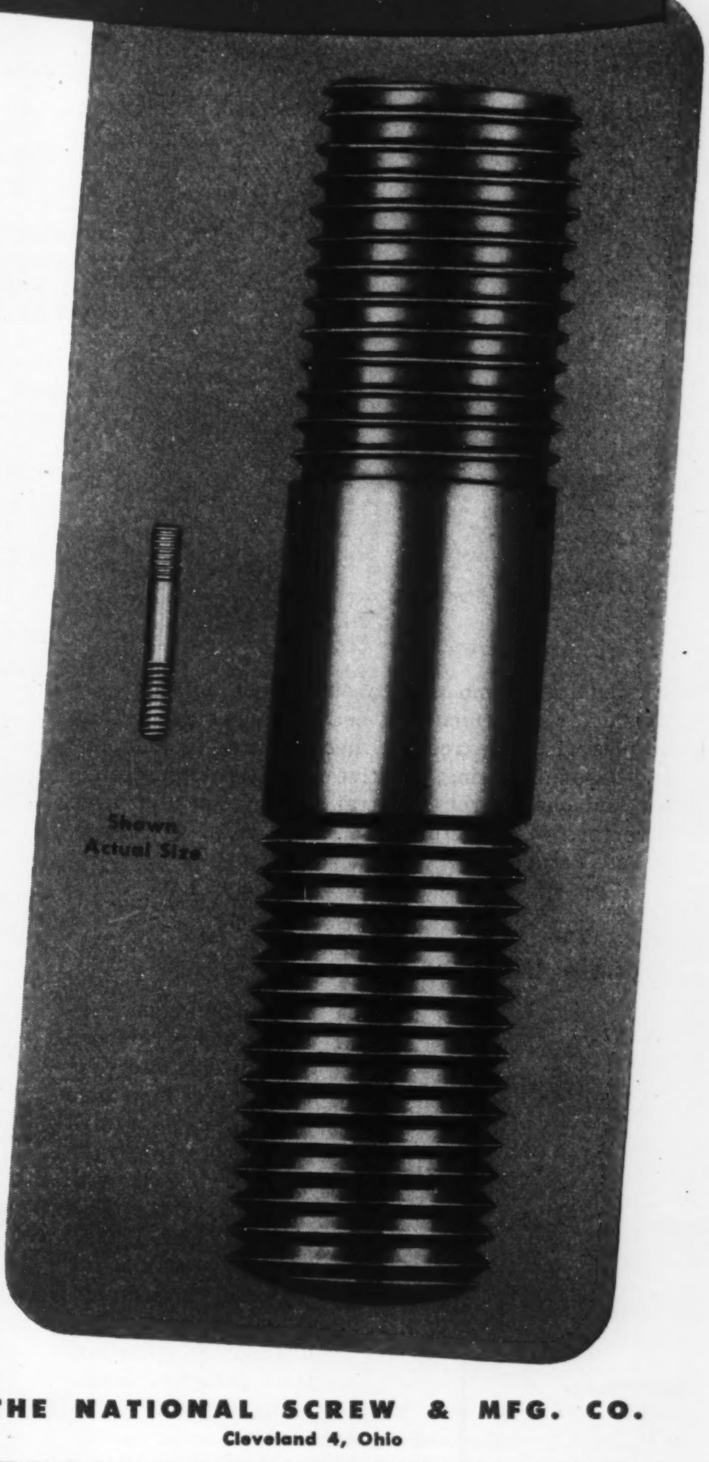
NOW . . . get Lok-Thred's greater strength . . more positive locking action . . in *any* size stud, bolt or screw

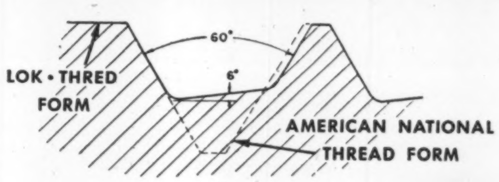


Are you making full use of LOK-THRED'S proved advantages—and its availability in any size or type of threaded fastener?

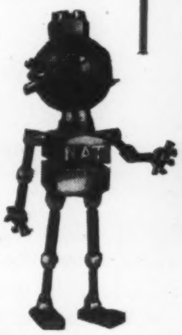
The revolutionary LOK-THRED design locks securely and becomes tighter in service . . . has much higher fatigue limits and is stronger in both tension and torsion than ordinary American National Threads...does not require selective fits.

These and other LOK-THRED features may offer important application advantages in your products. For full information, write for LOK-THRED booklet, today.

SEE THE DIFFERENCE!



Note Lok-Thred's larger cross section . . . and flat root surface instead of a relatively sharp "V" . . . as compared to the American National Thread form. Here's the secret of Lok-Thred's greater strength.



National
HEADED AND THREADED
PRODUCTS

THE NATIONAL SCREW & MFG. CO.
Cleveland 4, Ohio

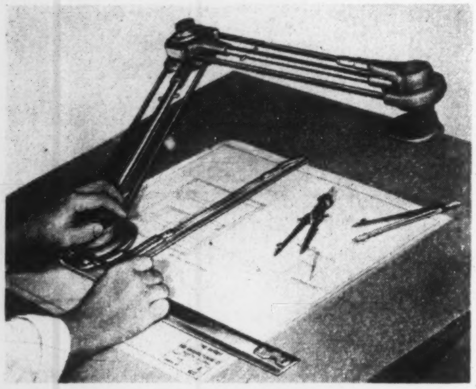
Pacific Coast: National Screw & Mfg. Co. of Cal.
3423 So. Garfield Ave., Los Angeles 22, Cal.

is of all-metal construction with all parts which contact chemicals of stainless steel, nickel castings and corrosion-resistant materials. Manufacturer: Haloid Co., Haloid St., Rochester 3, N. Y.

For additional information circle MD 34 on Page 173

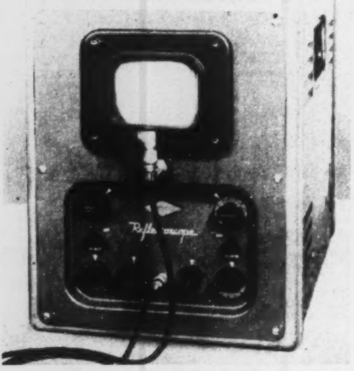
Drafting Machine

Sturdy spring counterpoise attached to support bracket of this Vemco Versatilt drafting machine permits it to function on drawing board tilted from 0 to 20 degrees. Indexing mechanism for setting 15-degree positions includes large thumb piece formed to afford secure grip from tip to root. Simple vertical movement of thumb release disengages indexing mechanism for convenience in setting angles other than multiples of 15 degrees. Other features include full circle baseline setting, positive band tightening, steel arms and band covers, central skid button and large protractor. Manufacturer: V. & E. Mfg. Co., P. O. Box 950, Pasadena 20, Calif.



For additional information circle MD 35 on Page 173

Portable Ultrasonic Tester



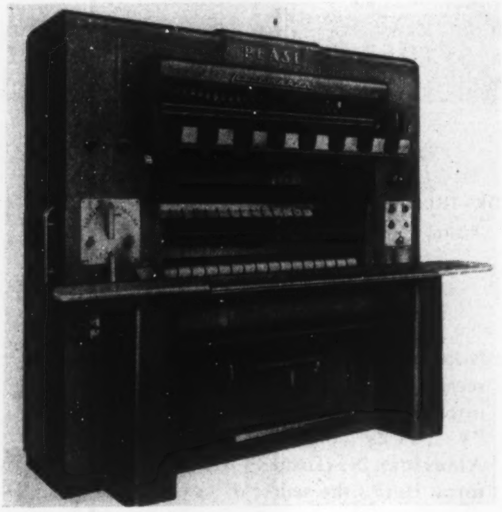
Steel billets, forgings, castings, finished stock, welds and wide variety of machined parts can be tested for defects by angle-beam technique with improved type UR style 50E351 Reflectoscope portable ultrasonic instrument. Unit transmits pulsed ultrasonic vibrations into material under test, at right angles to surface, by means of crystal transducer or searching unit. When vibrations are intercepted by defect or reach other side of material, they are reflected back to searching unit. Resulting indications on cathode-ray tube indicate start of pulse and reflected vibrations. Their position on horizontal axis accurately locates position of defect in material in relation to surface.

Modifications to facilitate interpretation of test results include improved pattern of square-wave inch markers on horizontal axis of screen. Reject control gives operator additional control of sensitivity by rejecting indications of small defects which do not affect performance of part or material under test. Removeable cover contains space for carrying all searching units and necessary cables. Rectangular bezel frames oscilloscope screen, and molded rubber bumpers protect corners of instrument. Carrying handles and controls are recessed, and removable bracket holds searching unit when not in use. Manufacturer: Sperry Products Inc., Danbury, Conn.

For additional information circle MD 36 on Page 173

Whiteprinting Machine

Ammonia vapor white prints are printed and developed continuously on cut sheets or rolls at speeds up to 32 fpm by Pacemaker automatic Whiteprinting machine. It reproduces tracings, drawings, foil, film or anything typed, written or drawn on translucent paper. By means of lever, either sliding-revolving contact or straight revolving contact can be selected to suit type and size of material being reproduced. Interlocking roller developer makes it possible to develop all types of diazo materials without sticking, scratching or wrinkling and prevents prints from becoming lost in developer or emerging distorted. Exposed prints are automatically conveyed into developer, while tracing or original copy is returned to operator for additional feedings.



Other features include instantaneous and positive speed control, cooling system which maintains constant low temperature across width of glass contact cylinder, and exhaust system that completely expels vapors. Machine operates on 200/250-v, 60-cycle

Light pressure seals for stamped and rough-cast parts

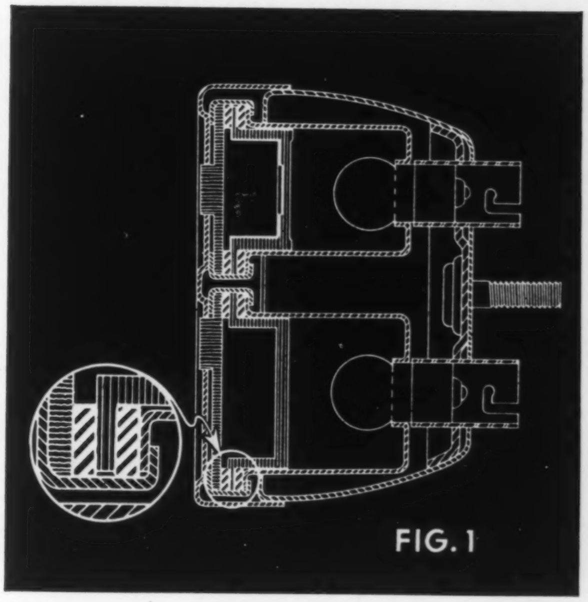


FIG. 1

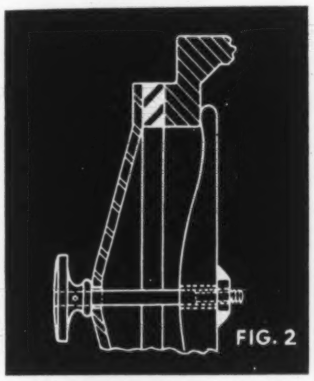


FIG. 2

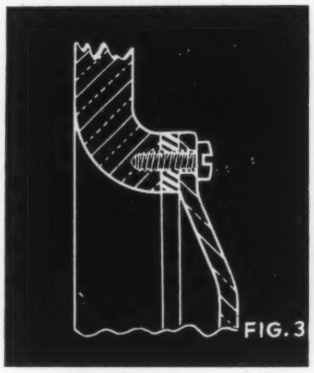


FIG. 3

Sealing stamped and rough-cast surfaces requires gasket materials with an unusual combination of properties. These materials must be soft enough to seal irregular surfaces without buckling light stampings. Yet they must be sufficiently firm to retain their kickback. And, of course, they must be impervious to the sealed medium.

These diverse requirements are met by Armstrong's Cork-and-Rubber Gasket Materials. Compressible cork particles dispersed throughout a matrix of synthetic rubber give cork-and-rubber its softness and lasting resilience without objectionable sideflow. Cork-and-rubber also has a resistance to fluid penetration that is comparable to straight synthetic rubbers.

In figure 1, for example, cork-and-rubber provides a weathertight seal on a stamped signal lamp housing. It conforms to surface irregularities in both the flanges and lens and cushions the lens against breakage. Resilient cork-and-rubber also reseals tightly when broken lenses and burned-out bulbs have been replaced.

Cork-and-rubber provides an effective seal for the stamped diesel hand hole cover in figure 2. Its softness permits economical light pressure assembly without buckling the cover. Yet despite frequent opening and closing of the cover, cork-and-rubber retains its sealing efficiency.

On waterproof electric motors, an unmachined cast flange and stamped cover plate are sealed with cork-and-rubber as shown in figure 3. Cork-and-rubber conforms to surface irregularities and is unaffected by exposure to oils and salt water.

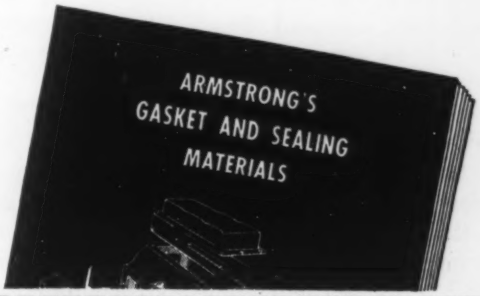
Light pressure seals are but one kind of problem solved by Armstrong's Cork-and-Rubber. Chances are, its unique properties can help seal your problem jobs. We suggest that you contact your Armstrong representative today.

Send for this Gasket Handbook

You'll find useful application and specification data in the revised 24-page booklet, "Armstrong's Gasket and Sealing Materials." It contains up-to-date information on straight synthetic rubber, cork-and-synthetic-rubber, and cork composition gasket and sealing materials.

This booklet includes ten technical discussions of the factors influencing modern gasket and joint design. It also suggests methods of putting Armstrong's stock materials to specialized uses in such fields as radio, electrical, automotive, petroleum, and transportation industries.

For your free copy, fill in coupon at right and mail today.



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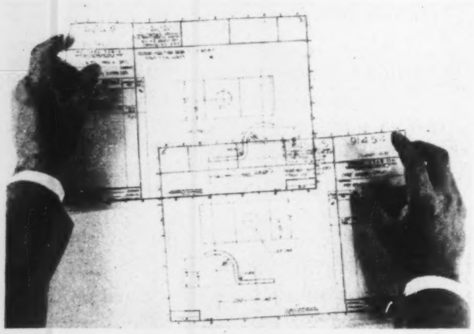
single phase alternating current with starting current of 32 amps and running current of 48 amps. Manufacturer: C. F. Pease Co., Chicago, Ill.

For additional information circle MD 37 on Page 173

Direct-Positive Film

By means of Kodagraph Autopositive film, positive copies can be produced directly from engineering drawings, maps and surveys. Film can be handled in normal room light and exposed on any copying machine having high-intensity light source. Highly translucent support affords high print-back speed, while high resolving power and contrast of silver-sensitized emulsion retain fine lines and minute detail. Consequently film is useful for restoring worn, stained or faded drawings without necessity of retracing.

Film can be printed with emulsion side in contact with face of drawing to produce reverse-reading positive which can be viewed easily from back to become, in effect, right-reading. When copying material printed on opaque stock or on both sides of page, it can be reflexed and right-reading print obtained by reading through back. Since film has matte surface on both sides, additions or corrections can be made in ink or pencil; and deletions can be made with standard two-solution eradicator. Film is available in 30 and 100-ft rolls in widths of 24, 30, 36, 42, and 44 in. Manufacturer: Eastman Kodak Co., Rochester 4, N. Y.

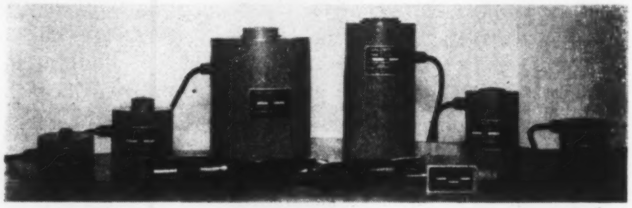


For additional information circle MD 38 on Page 173

Load & Pressure Cells

Utilizing SR-4 resistance wire strain gages, five models have been added to line of load and pressure cells. In load cells, gages are bonded to compression column so that loads are indicated or recorded manually or by self-indicating instruments. Two compression-type load weighing cells of 100,000 and 200,000-lb capacities are available, and size range of universal load cells for both compression and tension loads has been extended up to 100,000 lb. To supplement these cells, SR-4 load beams can be supplied to obtain load measurements down to 2 grams full scale.

Eleven sizes of fluid pressure cells are now obtainable, with addition of cell of 10-psi capacity on low end of scale and two cells of 100,000 and 150,000-psi capacities on high end. In these cells, gages are bonded to outside surface of pressure tube with open end that can be connected into pressure system. Manufacturer: Baldwin Locomotive Works, Philadelphia 42, Pa.



For additional information circle MD 39 on Page 173

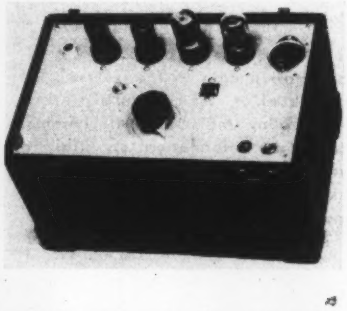
Bridge and Amplifier

This BA-1 bridge and amplifier, a standard cathode-ray oscilloscope and SR-4 strain gages form a system adaptable to measuring practically any mechanical reaction. Other resistive units in form of displacement, load, pressure and other pickups are handled effectively. Unit is a complete package of bridge elements, signal chopper, calibration system, amplifier and power supply. Load measurements, stress analysis and function analysis during operation show amplitude, frequency and waveform of sharp transients, steady state oscillations, static loads and their combinations. Displacement, acceleration, vibration, damping, timing, weight and pressure can be seen and measured during operation. Signal chopper frequency is 100 cycles per second, and gain is 0, 10, 150 and 3000 v. Frequency response is flat from 5 to 20,000 cycles per second with negligible phase shift. Power is supplied by batteries with life of 150 hours. Unit is completely portable. Manufacturer: Ellis Associates, Box 77, Pelham 65, N. Y.

For additional information circle MD 40 on Page 173

Calibrated Pre-Amplifier

Especially designed to extend sensitivity of line of graphic recorders to 30 microvolts, model PR calibrated preamplifier is an all-purpose self-contained laboratory instrument suitable for portable applications. Unit is available with selection of input impedances for use with multiplicity of low-output devices. Flat response from 40 to 40,000 cycles per second, dynamic range in excess of 60 db, and calibrated gain control in 5-db steps from 0 to 50 db, gives calibrated amplification into low output impedance. Manufacturer: Sound Apparatus Co., Stirling, N. J.



For additional information circle MD 41 on Page 173

Wichita City Library

HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

75. Oil & Coolant Filtering

Honan-Crane Corp.—Set of four illustrated booklets explains value of filtering oils and coolants used in metalworking operations such as cutting, grinding, boring, honing and quenching. Right method and equipment to handle any problem involving from 1 to 500 machine tools are discussed.

76. Bi-Metal Thermostats

Stevens Mfg. Co.—2-page bulletin F-2001 deals with type M bi-metal disk thermostats for use in communications equipment, appliances and electrical apparatus. Thermostat operation, typical response curve and construction data are included.

77. Hydraulic Pumps and Motors

Sundstrand Machine Tool Co., Hydraulic Div.—4-page illustrated form No. 132 contains data on PWX circuit pump for both feed and rapid traverse and fluid motor for infinite speed selection. Ratings, dimensions and features are listed.

78. Rotary Actuator

Airborne Accessories Corp.—4-page illustrated circular gives details of improved Rotorac electrically powered right angle type rotary actuator which features high power rating, low weight, built-in radio noise filter, adjustable center position switch for indicating or seeking and optional position indicating transmitter.

79. Powdered Metal Parts

Powdered Metal Products Corp. of America—8-page illustrated catalog is entitled "Powdered Metal in Your Production Picture." Featuring self-lubrication, variable density, special alloy properties, economy, precision, good wear resistance and low tool costs, powdered metal can be used for gears, bearings, valves, cams, filters and electronic elements.

80. Heat & Control Engineering

Westinghouse Electric Corp.—16-page illustrated booklet B-4031 tells about Therm-a-neering heat and control engineering service to aid in properly and efficiently applying controlled heat. Check list of Westinghouse standard thermostats is included which gives capacities, temperature ranges and applications.

81. Hard Surfacing

Coast Metals, Inc.—Illustrated booklet No. 649 details Hard metal surfacing of parts subject to high abrasion. Given also are production records of Hard cast rolls in metal forming operations.

82. Resistance Welding

Resistance Welding Institute—32-page illustrated booklet entitled "Design for Resistance Welding" explains advanced techniques in resistance welding processes. Theory and application of spot, seam, projection and butt welding are covered.

83. Laminated Plastic

Formica Co.—16-page illustrated catalog "Productive Formica at Work in Industry" evaluates each of 50 grades of this laminated thermosetting plastic material on properties such as water resistance, dimensional stability, mechanical strength, electrical characteristics, machinability and chemical resistance. Also covered are available forms, typical applications and methods of fabrication.

84. Alloy Steel

Jones & Laughlin Steel Corp.—36-page illustrated form No. AD155 contains data on Jalloy special alloy steel which is capable of being heat-treated to excellent physical properties for use where abrasion and impact resistance are major factors in service life. Tables on chemical composition, grain size, surface hardness and yield strength are included.

85. Photoelectric Counters

Photoswitch Inc.—2-page illustrated bulletin 20A1 gives details of several types of photoelectric counters for remote, high speed or selective counting of any type of object. Complete specifications and prices are given for all types of counters.

86. Indicating Pyrometer Controllers

Wheelco Instruments Co.—2-page illustrated bulletin PC-1 describes Panelmount Capacitrol series of indicating pyrometer controllers for temperature, voltage, current, speed and similar variables in process industries. Instrument features Wheelco electronic control principle, drawer-type chassis and complete front access.

87. Totally Enclosed Motor

U. S. Electrical Motors, Inc.—8-page illustrated bulletin 1524 presents U. S. Uniclosed motor of horizontal type available in ratings from ¼ to 250 hp. Features include armor-clad asbestos-protected windings, drip-proof housing, Lubriflush lubrication, cyclone ventilation, Centricast rotor and annealed laminations.

88. Air Valves

Bellows Co.—10-page illustrated bulletin AV100 gives details of standard air valves for remote control of single and double-acting air cylinders. Valves are button, lever, cam, clevis, treadle or foot operated. Two, three and four-way valves are available in ¼, ⅜, ½, ¾ and 1-in. port sizes.

89. Cast Iron

Meehanite Metal Corp.—4-page illustrated bulletin No. 32 presents complete tabular summary of engineering properties of various types of Meehanite castings available to industry. Also included are data important to casting designers concerning property changes as affected by variations in section sizes.

90. Bushings & Adapters

Dodge Mfg. Corp.—6-page illustrated bulletin A-420 discusses Taper-Lock weld-on hubs, bushings and adapters for mounting pulleys, sprockets, sheaves, gear or other hubs on shafting. Installation and removal are illustrated and sizes and specifications given.

91. Fluid Filters

Commercial Filters Corp.—4-page illustrated bulletin No. 1000-B-2 gives details of Fulflow filters and Honeycomb filter tube for clarification of wide range of liquids and gases. Principle of operation, applications, tube densities, capacities, filter sizes and variety of models are described.

92. Hydraulic Tubing

Superior Tube Co.—4-page illustrated bulletin No. 38 gives general and technical information as well as specifications on line of seamless steel hydraulic tubing from ⅛ to 1⅛-in. OD, in wall thicknesses for every practical operating pressure.

93. Custom-Cut Gears

Perkins Machine & Gear Co.—4-page illustrated folder on custom-cut metallic or non-metallic gears presents typical applications that include washing and ironing machines, aircraft engines and accessories, machine tools, precision instruments, coal stokers, hoists and pumps.

94. Specialized Fastenings

Shakeproof, Inc.—12-page form AS-31 is entitled "Fastening Analysis by Shakeproof" and tells of specialized fastenings service. Brief case histories show economies that have been achieved in variety of industries through proper fastenings which simplify design and eliminate unnecessary parts and operations.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below

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3	23	43	63	83	103
4	24	44	64	84	104
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Cleveland 13, Ohio

Please send literature or detailed information on subjects circled at left to—

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COMPANY _______________

MACHINES MANUFACTURED _______________

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CITY AND STATE _______________

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95. Speed Control
Reeves Pulley Co.—12-page illustrated folder G471 discusses applications, operating principles and advantages of Reeves speed control to provide any driven machine with accurate stepless speed adjustability. It can be used to widen work range of machines, assure accurate timing, compensate for changes in consistency of materials and closely regulate conveyor speeds.

96. Zinc Base Metals
American Nickeloid Co.—Illustrated folder explains available types of zinc base metals furnished in sheets, coils or flat strips. Samples of both bright and satin finished metals are included. Material can be supplied plated on one or both sides in striped or crimped patterns. These preplated metals can be stamped, blanked, bent or formed to meet most design requirements.

97. Metal Powders
National Radiator Co., Plastic Metals Div.—4-page illustrated bulletin No. 567 deals with various grades of iron powder as well as nickel, manganese, silicon and other nonferrous powders. Shown are various parts that can be fabricated from metal powders and number of special uses to which they can be applied.

98. Precision Gears
Massachusetts Gear & Tool Co.—4-page illustrated bulletin No. 49328 lists available diametral pitches, pitch or outside diameters and face lengths or lengths of spur, helical, straight bevel, face and worm gears; worms; generated pinion rod; racks; ratchets; sprockets and miscellaneous gear types.

99. Hydraulic Cylinders
Hydraulic Equipment Co.—4-page illustrated folder No. C-20649 is on standard design, single and double-acting cylinder assemblies. Recommended operating pressures, effective diameter, stroke required and other vital information are given.

100. Nonferrous Castings
Wellman Bronze & Aluminum Co.—16-page illustrated catalog No. 50 describes nonferrous castings and wood and metal pattern operations. Included are data on magnesium alloys, polishing of aluminum, Well-Castings, copper base alloys and Ampco pattern shrinkages.

101. Copper Abrasive
American Wheelabrator & Equipment Co.—4-page illustrated bulletin No. 69 explains advantages of using copper shot for blast cleaning and finishing nonferrous metal parts. Performance results are enumerated and advantages listed.

102. Spray Lubricators
Frontier Industries, Inc., Manzel Div.—4-page illustrated bulletin "Manzel Spray Lubricating System" explains operation of this equipment which lubricates punch and shear operations. Utilizing force-feed principle, unit applies adjustable amount of lubricant directly to punch, die, shear or other tool at each stroke.

103. Analyzing Instruments
Century Geophysical Corp.—Five illustrated bulletins present complete details on line of equipment which includes five recording oscillographs, two galvanometers, two oscillographs and amplifier for use with analyzing equipment.

104. Relays
Sterling Engineering Co.—4-page illustrated bulletin No. 110 is devoted to type GS short form telephone relays. Spring assemblies, dimensions, contact arrangements and voltages are listed.

105. Metal Fabrication
L. O. Koven & Brother, Inc.—24-page illustrated bulletin No. 490 is entitled "Men, Facilities and 'Know How' ". Production and engineering facilities for fabrication of metals in all gages from 18-gage to heaviest plate are described.

106. High-Vacuum Pumps
F. J. Stokes Machine Co.—32-page illustrated catalog No. 700 contains engineering information, specifications and other data relative to Microvac high-vacuum pumps and their use in producing pressures as low as 0.00002 psia. Many industrial applications are listed, installations shown, and typical problems and their solutions presented.

107. Battery Chargers
Electric Products Co.—4-page illustrated bulletin 234 outlines design features of type S single-circuit motor-generator battery charging equipment. Units are available in wide range of sizes to handle both lead-acid and Edison types of industrial storage batteries.

108. Stainless Pipe & Tubing
Babcock & Wilcox Tubing Co.—4-page illustrated bulletin TDC-130 deals with Croloy 18-8S type 304 stainless pipe and tubing. Condensed data are presented on corrosion resistance, creep strength, oxidation resistance, mechanical properties, machinability, welding characteristics, heat treatment and physical properties.

109. Heat Exchange Coil
Kold-Hold Mfg. Co., Platecoil Div.—4-page illustrated bulletin I-49 explains how Platecoil units eliminate many problems in tank heating and cooling applications. Available sizes, heat exchange surfaces and typical applications are covered also.

110. Stampings & Forgings
Commercial Shearing & Stamping Co.—28-page illustrated brochure presents design factors, applications and advantages of line of stampings, forgings, hydraulic equipment and assembled products that are 'Factory Fashioned'.

111. Fastening Specialties
South Chester Corp.—28-page illustrated manual is entitled "Fastening Specialties Handbook." Descriptive and engineering data are presented on Southco blind rivets, anchor nuts, panel fasteners, door-retaining springs and other specialties for fastening metal to metal or to wood.

112. Flexible Hose Assemblies
Resistoflex Corp.—4-page illustrated bulletin "Synthetic Flexible Products and Parts for Industry" describes Compar-tubed flexible hose assemblies for original equipment. Typical uses such as in hydraulic, refrigerant, lubrication and chemical lines are cited.

113. High Current Resistor
Exmet Electrical Corp.—6-page illustrated folder describes Multipath high current resistor for industrial, marine and transportation applications. Typical uses of this unit include low-cost large-quantity power disposal, radiant heating at 'black' temperature and forced draft heating.

114. Gear Drives & Reducers
Universal Gear Corp.—8-page illustrated bulletin "Universal Uses of Our Units" shows and briefly describes various types of gear drives and speed reducers in range of ⅛ to 10,000 horsepower. Heliocentric principle used in high ratio concentric universal units is explained and covered by sectional drawing.

115. Magnetic Relays
Ward Leonard Electric Co.—12-page illustrated catalog D-20A contains descriptions of seven standard types of magnetic relays for industrial and general-purpose control applications. Complete technical data on relay ratings, dimensions, coil specifications and applications are included.

116. Pneumatic Controls
Bendix-Westinghouse Automotive Air Brake Co.—16-page illustrated bulletin "Robotair Industrial Air Controls" explains use of short-stroke chambers, medium-stroke units, two and three-way valves, pressure regulating and quick-release valves, filters, checks, gages, air reservoirs and tubing fittings as components of complete machines and mechanisms.

117. Low Melting-Point Alloys
Cerro de Pasco Copper Corp.—4-page illustrated folder J4-6-49 lists all known applications of low-temperature-melting Cerro alloys. Characteristics of materials which expand when changing from liquid to solid are explained. Physical properties of available types of alloys are outlined briefly.

118. Vacuum Coatings
Distillation Products, Inc.—12-page illustrated booklet entitled "Vaporized Metal Coatings by High Vacuum" describes standard units for vacuum coating various objects. Surfaces produced have greater brilliance than depositions applied either by electrolysis or by paint and require no hand finishing or buffing. Method can be employed on many surfaces including glass, plastics, paper, metal, crystals, cloth or any substance that retains its solid state and does not have too high vapor pressure under high vacuum.

119. Precision Parts
Kohler Co.—24-page illustrated catalog describes precision air and hydraulic parts produced for aircraft, industrial and automotive manufacturers. Complete data including connections, operating pressures, open pressures, rates of flow, sizes, pressure drop, material and weight are given for each product.

120. Capacitors
Stackpole Carbon Co.—4-page illustrated form RC 7E-1500 deals with characteristics, performance and testing of GA capacitors that can be obtained in six standard capacities ranging from ½ to 4.7 micromicrofarads. Dimensions and color coding are also given.

M. D. Numbers

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4	24	44	64	84	104
5	25	45	65	85	105
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Break with tradition . . . design your tools with strength and *lightness* in mind and you'll choose forged aluminum! Alcoa Forgings save on muscle . . . sell tools because they are strong, can cut weight in half.

Think it over. Perhaps Alcoa's vast experience with the aircraft industry's forging needs can be applied to *your* advantage. For help on redesign, for helpful facts and figures on aluminum forgings for your product, call your nearby Alcoa Office. Or write ALUMINUM COMPANY OF AMERICA, 1940-M Gulf Building, Pittsburgh 19, Pennsylvania.

Design Advantages of Alcoa Forgings

- Best combination of lightness, strength, compactness
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INGOT • SHEET & PLATE • SHAPES, ROLLED & EXTRUDED • WIRE • ROD • BAR • TUBING • PIPE • SAND, DIE & PERMANENT MOLD CASTINGS • FORGINGS • IMPACT EXTRUSIONS
ELECTRICAL CONDUCTORS • SCREW MACHINE PRODUCTS • FABRICATED PRODUCTS • FASTENERS • FOIL • ALUMINUM PIGMENTS • MAGNESIUM PRODUCTS

There's a **Cambridge**

WIRE BELT

to combine movement with processing

for **EVERY PRODUCT**
. . . or MATERIAL

A Cambridge Balanced Belt safely and speedily carries clock faces through the decorating lehr. In a modern ceramics plant, Cambridge belts can also be used for annealing and glazing. Open mesh permits free heat circulation around the ware. Moving belt eliminates use of cars or saggers.

Whether your product is big and bulky or small and fragile, if it must move during processing or production, a Cambridge Woven Wire Conveyor Belt can do the job economically and safely.

Woven from any metal or alloy to any mesh or weave, Cambridge belts offer dependability, long life, freedom from time-wasting shutdowns for repairs. Among the specially designed Cambridge belts in service today are continuous conveyorized installations for baking, quenching, tempering, washing, drying, cooling and packaging.

Whenever you have a problem concerning movement during processing, call in a Cambridge Field Engineer.

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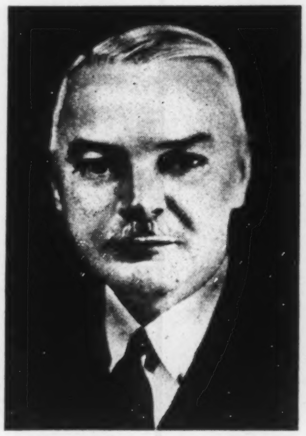
OFFICES IN PRINCIPAL INDUSTRIAL CITIES

MEN OF MACHINES

James D. Cunningham, president of Republic Flow Meters Co., Chicago, will take office as president of The American Society of Mechanical Engineers at the end of the annual meeting in New York in December. He will succeed **James M. Todd,** consulting engineer of New Orleans. Regional vice presidents taking office at the same time will include **Frank M. Gunby** of Chas. T. Mann Inc., Boston; **John C. Reed,** head of mechanical engineering department, Bucknell University, Lewisburg, Pa.; **Albert C. Pasini,** assistant superintendent, production department, Detroit Edison Co., Detroit; and **Samuel H. Graf,** director of engineering experimental station, Oregon State College, Corvallis, Ore. Directors at large will be **Thomas E. Purcell** and **Benjamin P. Graves.**



James D. Cunningham

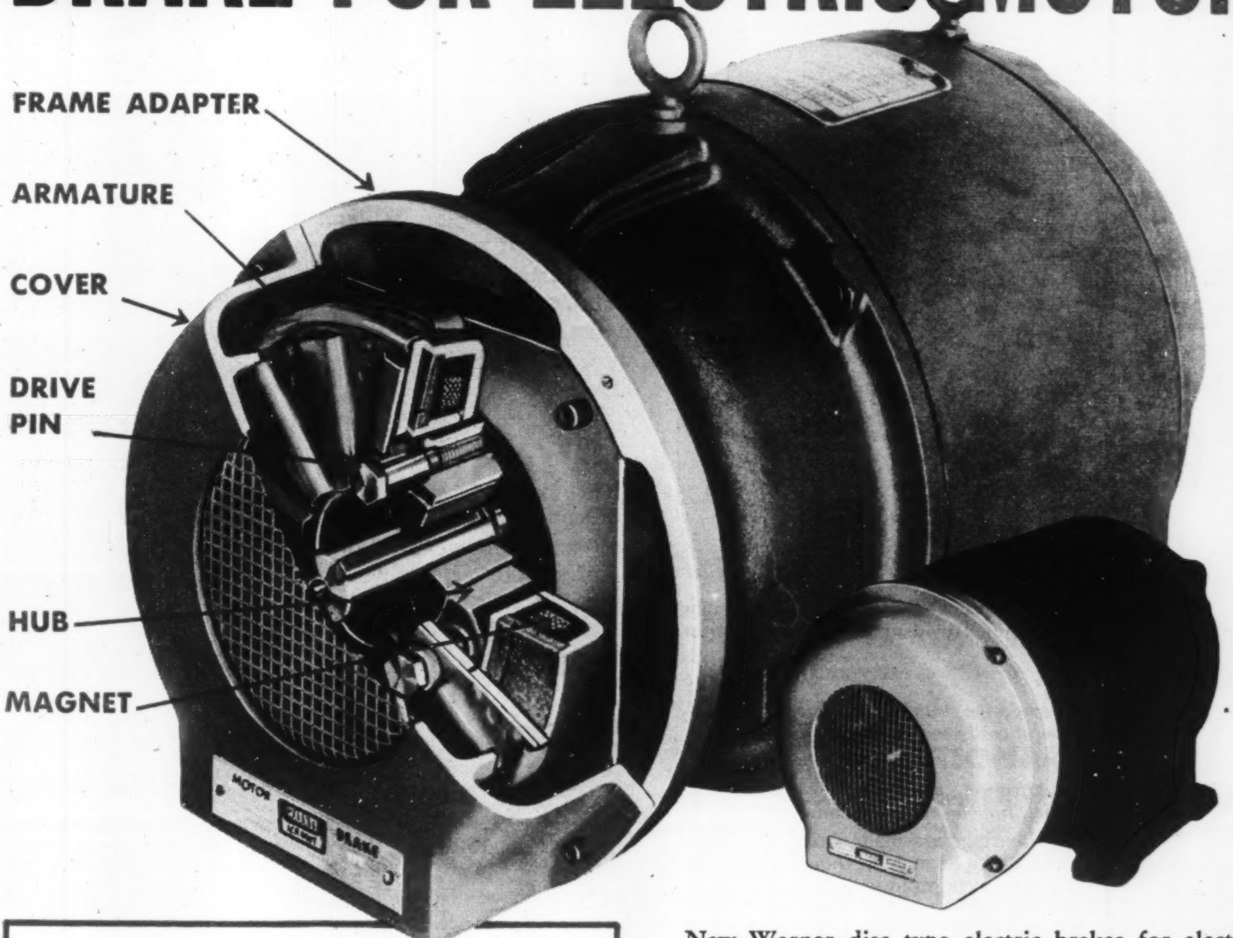
G. K. Eggleston

Appointment of **G. K. Eggleston** as vice president in charge of manufacturing of Non-Ferrous Perma Mold Inc., Mansfield, Ohio has been announced. Owned jointly by the Barnes Manufacturing Co. of Mansfield and the Non-Ferrous Die Casting Co. Ltd. of London, Eng., this new corporation manufactures permanent-mold castings. Prior to his present appointment, Mr. Eggleston was vice president of engineering for the Barnes Manufacturing Co. From 1922 to 1941 he was with the Detroit Lubricator Co.

◆

According to a recent announcement **Edgard C. DeSmet** has been named to the newly created post of director of body engineering for Willys-Overland Motors Inc., Toledo, Ohio. In addition to his present duties as head of the styling department he will be

ANNOUNCING A NEW DISC TYPE BRAKE FOR ELECTRIC MOTORS



THIS REVOLUTIONARY NEW BRAKE GIVES YOU ALL THESE ADVANTAGES:

- Instant Operation
- Fast Controlled STOPPING
- NO adjustment for life
- Unmatched ability to dissipate heat
- Fewer parts
- Compactness and ease of installation
- Low power requirements— max. 25-35 watts
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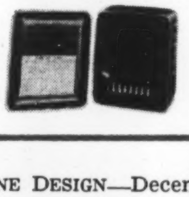
POWER CONVERSION UNIT

Warner brake coils are wound for full current application of 90 Volts D.C. D.C. power may be obtained from a D.C. source or any standard A.C. supply with a Warner conversion unit. Warner conversion units supply a maximum of .40 amperes at 90 Volts D.C. when connected to any A.C. voltage source.



New Warner disc type electric brakes for electric motors exert a constantly increasing torque throughout stopping period. Standard units now available for horizontal shaft mounting. All Warner disc type electric brakes for electric motors are designed to fit NEMA motor specifications. These units have been thoroughly field tested and yield amazingly practical results. Write today for complete information.

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ICB UNIT

Warner Electric Brakes for
Transportation and Industry
Since 1927

WARNER ELECTRIC BRAKE MFG. CO.
BELOIT, WISCONSIN

Please send me bulletin 702 with complete information on Warner Electric Disc-Type Brakes for Electric Motors.

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OIL-RETAINING
POROUS BRONZE BEARINGS

Why
Nationally-Known
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SELF-LUBRICATING BEARINGS
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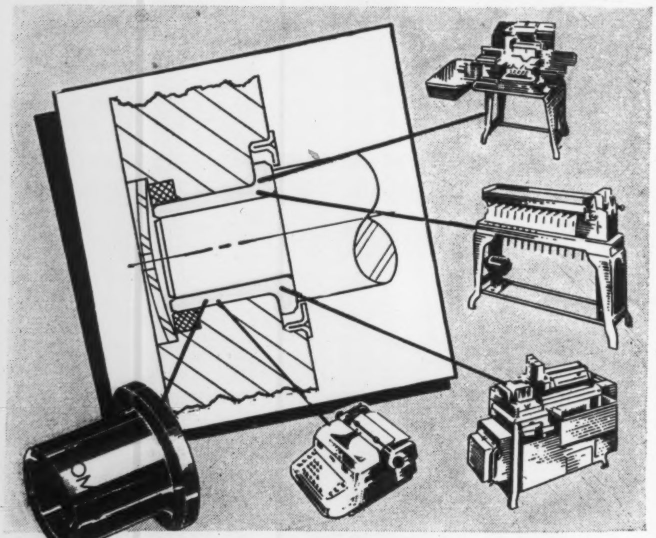

Switching to Bound Brook "COMPO" Self-Lubricating Flanged Bearings meant more than providing for severe end thrust. It meant:

To the manufacturers:
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To end users:
- *No periodic lubrication, maintenance costs cut, and continuous, quiet, trouble-free operation.*

"COMPO" Porous Bronze Bearings are made from pure metal powders, die-formed to shape, alloyed at high temperatures, finished to exact dimensions, and vacuum-impregnated with lubricant. Self-lubricating qualities make them ideal for use in inaccessible spots. The lubricant is sealed in, free from dirt, and an even lubricating film is always present.

Thousands of "COMPO" Bearing sizes can be made from existing dies; hundreds of sizes in stock for prompt shipment. Use coupon below, to get our free Stock List or arrange a conference with one of our engineers. *We've saved time and costs for others; we can do the same for you.*

Many other types of "COMPO" Bearings and "COMPO" structural parts have been designed into business machines, appliances and other types of equipment at equal savings and with equal performance benefits.

BOUND BROOK OIL-LESS BEARING COMPANY
BEARINGS • BUSHINGS **WASHERS • PARTS**
BOUND BROOK, N. J. **ESTABLISHED 1883**

Bound Brook Oil-Less Bearing Co.
Bound Brook, N. J.
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responsible for planning and directing all body engineering at Willys. Joining the company in 1936 as body engineer, he has served successively as assistant chief engineer, chief engineer of the wartime aircraft division, and assistant to the vice president in charge of engineering. Prior to joining Willys-Overland he was with the Locomobile Co., Dodge Bros., Briggs Mfg. Co., Hudson Motor Car Co., and Chrysler Corp.

◆

S. W. Steininger has become design engineer for Fairchild Engine & Airplane Corp., Oak Ridge, Tenn. He previously held a similar position with the Hercules Motors Corp., Canton, Ohio.

◆

Appointment of **William A. Wilson** as associate professor of mechanical engineering at the Massachusetts Institute of Technology has been announced. A graduate of Columbia University, Professor Wilson's industrial experience includes six years with Westinghouse Electric Corp. as experimental engineer on steam turbines, and seven years as mechanical division engineer at the Elliott Co.

◆

Elected to the newly created post of executive vice president of the De Vilbiss Co., Toledo, Ohio, is **Ray L. Morrison.** He has been general manager of the brake division of Timken-Detroit Axle Co., and previous to that was vice president and general manager of Bendix-Westinghouse in Pittsburgh and Elyria.

◆

Jules P. Kovacs has been elected vice president in charge of engineering of Purolator Products Inc., Newark, N. J. Having joined Purolator as a design engineer in 1929, he was appointed chief engineer in 1941.

◆

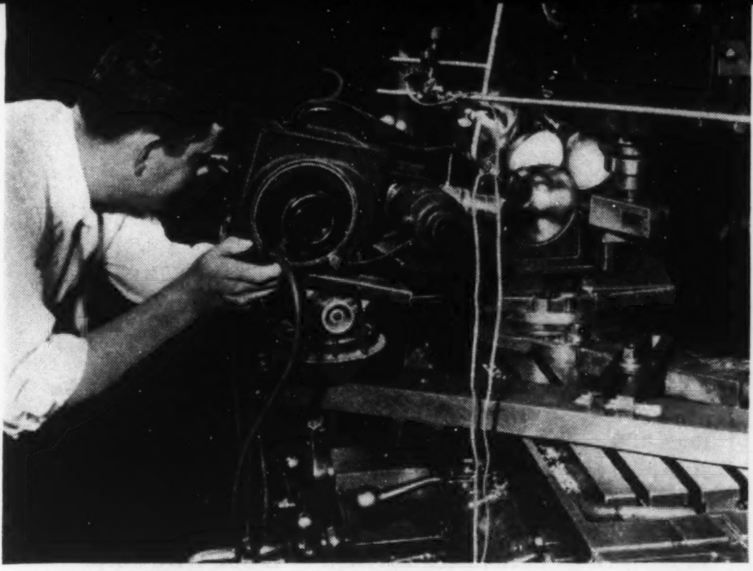
Thomas D. Jolly, vice president in charge of engineering and purchases, Aluminum Company of America, Pittsburgh, was re-elected president of the American Standards Assn. **Harold S. Osborne,** chief engineer of American Telephone & Telegraph Co., New York, was re-elected vice president.

◆

Harry G. Bolton has recently been appointed chief engineer of the Marvel-Schebler Carbureter Division of Borg-Warner Corp., Flint, Mich. He has been associated with the engineering department of the division since 1928 and in 1940 was appointed assistant chief engineer.

◆

Election of **Chester M. MacChesney** as chairman of the board of directors of Acme Steel Co., Chicago, has been announced. He became associated with Acme in 1916 as a design engineer and in 1948 was made executive vice president.



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HERE YOU SEE a few examples of how the speed of photography serves industry. In addition, its accuracy is used in copying drawings, documents, and data of all kinds. Its ability to reduce can put records on microfilm and save 98% of filing space.

These and the other unique qualities of photography are helping cut costs, improve products, speed production, and stimulate sales. If you would like to know more about how it could serve you, write for literature or for specific information which may be helpful to you. Eastman Kodak Company, Rochester 4, N. Y.

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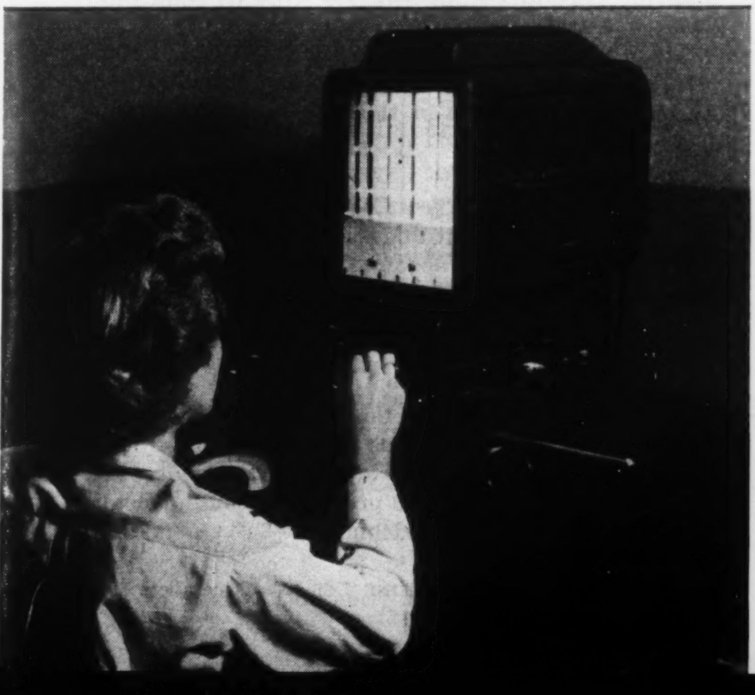
IT ANALYZES CHEMICALS IN A FLASH—Spectrography with Kodak Spectrum Analysis Film and Plates quickly determines the composition of almost all materials. It provides a means to make frequent production-line analyses. It can maintain a check on specifications and speed up output.



IT RECORDS THE FLICK OF INSTRUMENTS—The swift swing of the galvanometer mirror or cathode-ray tube beam is not too fast for photography. Readings of these instruments are quickly recorded on Kodak Linagraph Films and Papers so that they can be studied and full advantage taken of the facts that they reveal.

Graham
THE FINEST Variable Speed Drive MADE

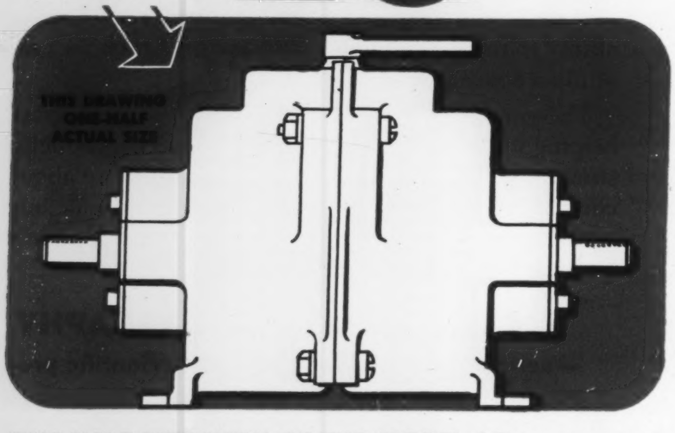
1. GUARANTEED MOST ACCURATE
2. WIDEST RANGE
All speeds from top to zero (plus reverse if wanted without stopping motor)
3. MOST COMPACT

NOW IN A NEW MIDGET SIZE

$29.75
F. O. B.
Milwaukee

Price to O.E.M. Buyer, less quantity discount

MODEL 10



ONE-HALF SIZE VIEW OF THE MODEL 10 The Model 10 is ideal for small machines such as pumps, feeds and feeders, business machines, instruments, recorders, controllers, etc. etc.

MODEL 10 SPECIFICATIONS
H.P. OUTPUT — 1/15 H.P.
INPUT SPEED — 1800 RPM standard — other as required
OUTPUT SPEED — from 2/3 input speed to zero and reverse
TORQUE — 50 in. oz.
CONTROL — Finger-tip lever — 60° motion
LUBRICATION — sealed-in oil or grease

OTHER SIZES UP TO THREE HP — For quick delivery of a Model 10 or full data on the Graham line, use the coupon, or return the Reader Service Card inserted in this magazine.

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☐ Send full data on the Graham Drive in sizes up to 3 HP, no obligation.

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MD NEWS OF MANUFACTURERS

Purchase of all machinery, tools, inventory, buildings and real estate of **Cords Ltd.,** 780 Frelinghuysen Ave., Newark, N. J., has been announced by **Essex Wire Corp.,** manufacturer of wire and wire products. The new owner will continue to operate this business in Newark as **Cords Ltd., Division of Essex Wire Corp.**

◆

Victor Equipment Co., San Francisco, Calif., has announced the purchase of the business and assets of **Mills Alloys Inc.,** 11320 Alameda St., Los Angeles, Calif. The manufacturing facilities purchased by Victor will continue to be located at the leased site now occupied by Mills Alloys and will be designated as the **Alloy Rod and Metal Division of Victor Equipment Co.**

◆

The **United Engineering Co.** has announced the completion of a new department devoted entirely to high-precision machine shop work at United's San Francisco plant, 500 Beale St. The shop, with $175,000 worth of precision tools, is at work on intricate machinery for aircraft manufacturers and radar equipment for use by the Navy.

◆

Cone-Drive Gears, Division of Michigan Tool Co., Detroit, Mich., has announced the purchase of the Twelfth St., Traverse City, Mich., plant of **Parsons Corp.** The plant, built during the war, covers approximately 40,000 sq ft.

◆

Non-Ferrous Perma Mold Inc., a new company jointly owned by the **Barnes Mfg. Co.,** Mansfield, O., and the **Non-Ferrous Die Casting Co. Ltd.,** London, England, has been incorporated under the laws of the State of Ohio, with factories in Mansfield, Ohio. British process techniques have been brought here through the formation of this new corporation.

◆

Assets of **The O. K. Tool Co.,** Shelton, Conn., manufacturer of single point and inserted blade type milling cutters, have been acquired by **Williams & Hussey Machine Co.,** Wilton, N. H., manufacturer of special machinery and "Star" gages.

◆

The **Pickering Governor Co.,** Portland, Conn., manufacturer of governors, has been acquired by the **Henry & Wright Division of Hartford-Empire Co.,** manufacturer of high-speed presses for continuous die work and other special machinery. The parent com-

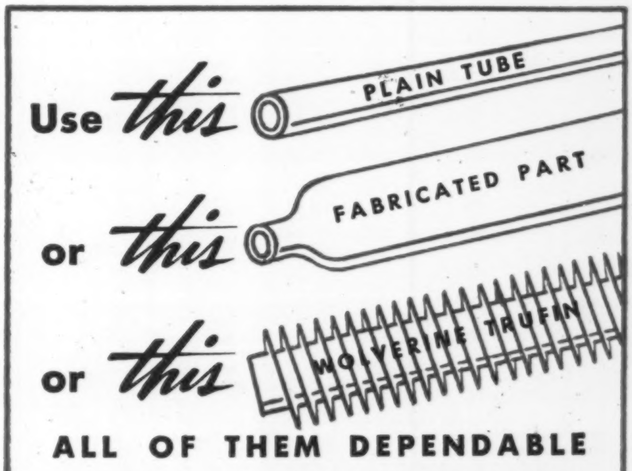
How to Reduce Manufacturing Costs

It's not always easy to put your finger on the exact places where economies in manufacturing can be affected.

Sometimes these economies are found outside your own manufacturing processes—among the assembled parts—brought in by suppliers of the various components making up your product.

If tubing or tubular parts form a part of the products you make—it's to your advantage to see that such components are supplied by specialists—specialists like Wolverine Tube, who have been manufacturing tubing exclusively for over thirty years. To draw on this wealth of experience means economies to you. We can help you (just as we have helped thousands of other manufacturers) to utilize tubing—plain, finned (Wolverine Trufin) or fabricated—in a way that can reduce your manufacturing costs. We have shown many manufacturers, for instance, how they could make their tubular parts more economically by using tube than by continuing with the method they were employing. We have also pointed out ways to substantial economies, where heat transfer is involved, through the use of Wolverine Trufin (the integral finned tube).

Wouldn't you like to learn more about these economies? Have one of our engineers call on you to discuss these matters. No obligation.



ALL OF THEM DEPENDABLE
MADE BY WOLVERINE

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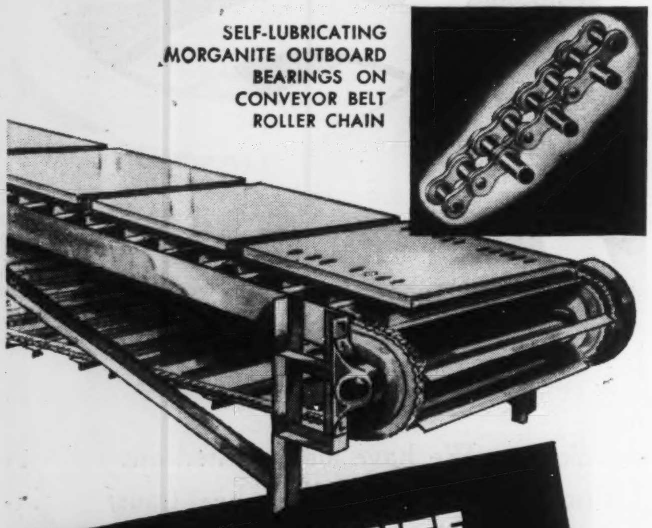
CALUMET AND HECLA CONSOLIDATED COPPER COMPANY
INCORPORATED
MANUFACTURERS OF SEAMLESS NON-FERROUS TUBING
1433 CENTRAL AVENUE DETROIT 9, MICHIGAN

PROBLEM: Outboard bearings on extended pin roller chain conveyor . . . to withstand degreasing vapor, dipping bath fumes, high heat, water dip, steam, phosphoric acid spray.

SOLUTION: A Morganite bearing . . . the special bearing for special conditions . . . meets all requirements . . . is entirely self-lubricating under all conditions.


SELF-LUBRICATING MORGANITE OUTBOARD BEARINGS ON CONVEYOR BELT ROLLER CHAIN

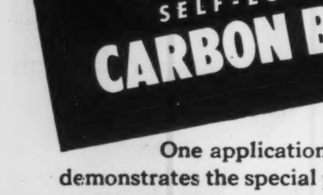
MORGANITE SELF-LUBRICATING CARBON BEARINGS

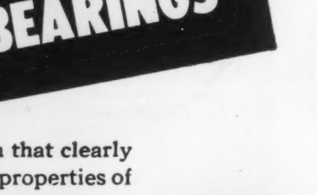
One application that clearly demonstrates the special properties of Morganite bearings is their use on conveyor belts involving continuous changes of atmosphere and temperature. Bearings, pump blades and seal rings of Morganite easily withstand these conditions . . . actually operate better when submerged in liquids. They are immune to oil, petroleum, water, brine, most acids and alkalies. Being self-lubricating they do not contaminate contacting liquids and materials with grease or oil, impart no odor or taste.

see our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS

Additional data on Morganite will be found in Sweet's File for Product Designers. For competent engineering help on specific problems consult a Morganite sales engineer. There is no obligation.

REGISTERED TRADE MARK **Morganite** INCORPORATED
LONG ISLAND CITY 1, NEW YORK


Conveyor hanger roller with Morganite bearing requires no lubrication


Morganite conveyor bearing on extended pin of roller chain

Manufacturers of Morganite Carbon Brushes for all motor and generator applications, and Morganite Carbon Piles.

pany, **Hartford-Empire,** manufacturer of glass container machinery, has as its other associates: **Plex Corp. Division,** developer of machinery for extruding and blowing various plastics materials which it markets; and the **Standard-Knapp Division,** manufacturer of packaging machinery.

◆

Allied Research Products Inc., Baltimore, Md., manufacturer of Iridite finishes, has purchased the building at 4004 E. Monument St., which has housed the company for the past three years. Plans are being drawn for extensive interior renovations which will include larger research and manufacturing facilities, increased space for metal finishing operations, and new administrative and sales offices.

◆

Quarters of **Kraus Design Inc.,** manufacturer of automatic parts and handling equipment, have been moved to 950 Exchange St., Rochester 8, New York.

◆

All the properties and assets of **DeWalt Inc.,** manufacturer of radial saws for high-speed cutting of wood, light metals and plastics, have been purchased by **American Machine and Foundry Co.,** New York, N. Y. AMF will continue operation of the 75,000-sq ft plant, at Lancaster, Pa., with the present personnel through a wholly-owned subsidiary.

◆

The **Pittsburgh Plate Glass Co.,** Pittsburgh, Pa., has announced plans for the construction of a paint plant at Torrance, Calif. The plant, which will have 157,000 sq ft of floor space, loading docks and covered walkways, is expected to go into production within ten to twelve months.

◆

Logan Engineering Co. has announced the merging of the **Dor-O-Matic Co.** into the Logan organization. Manufacture of the Dor-O-Matic door control has been transferred from the Dor-O-Matic factory, 818 S. Kolmar Ave., Chicago, Ill., to the recently enlarged Logan Engineering plant, 4901 West Lawrence Ave., Chicago, Ill. In addition to the activities of its new **Dor-O-Matic Door Control Division.** Logan Engineering will continue the manufacture of Logan lathes at the Lawrence Ave. plant.

◆

Opening of a new 45,000-sq ft plant located at 3203 South Wayside, Houston, Tex., has been announced by the **Link-Belt Co.,** manufacturer of chains, elevators, conveyors and power-transmitting machinery.

◆

A 30-minute technicolor sound film, "This Moving World," has been produced for the **Malleable Founders' Society,** Cleveland, O., by Roland Reed Productions, Hollywood, Calif. The film tells in dramatic fashion the part played in the industrial world by malleable castings.

Key to Savings
SHENANGO-PENN
CENTRIFUGAL
CASTINGS

Two views of a steel mill table roll body cast of Meehanite Metal by the Shenango-Penn *Centrifugal* process, assuring exceptional life. Note exterior and interior machining. Shenango-Penn facilities include modern equipment for economical machine work of virtually every type and to any stage to best meet your particular needs.

Maybe you can profit by steel mill experience

THIS conveyor roll is going to save a steel mill some money. Because it is a Shenango-Penn *centrifugal* casting of Meehanite Metal, it will hold up longer than an ordinary roll . . . won't need replacement nearly so soon! That's good economy, don't you think?

Fundamentally that's why Shenango-Penn is producing symmetrical, annular and tubular parts, large and small, ferrous and non-ferrous, for many services in many industries. The Shenango-Penn *centrifugal* casting process results in more uniform, pressure-dense parts with finer grain, greater strength, superior wear resistance and freedom from sand inclusions and blow holes. Metal for metal, dollar for dollar, they do a better job. It pays!

As always, we welcome the chance to give you further evidence, specific facts, as to why it will pay *you* to specify Shenango-Penn. Send for a free bulletin on our ferrous or non-ferrous made-to-order centrifugal castings or on our *centrifugally cast* bronze bushing stock in standard sizes.

SHENANGO-PENN MOLD COMPANY
1277 West Third Street • Dover, Ohio
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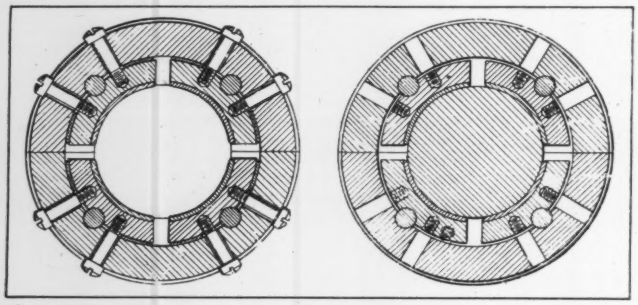
SHENANGO-PENN

ALL BRONZES • MONEL METAL
NI-RESIST • MEEHANITE METAL
®

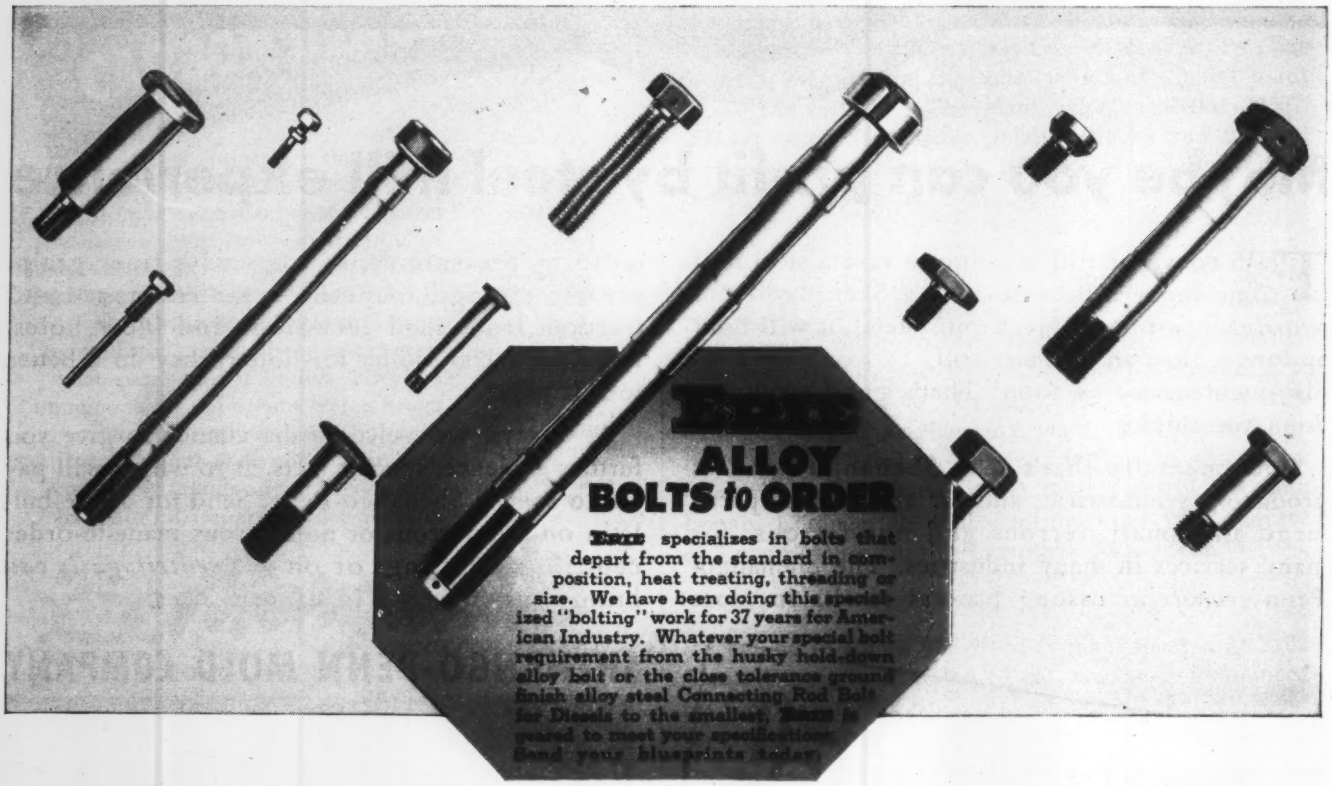
NOTEWORTHY PATENTS

TILTING PAD BEARINGS for rotating shafts are made by a unique method described in patent 2,480,114. Several circumferential bearing pads are shimmed and held to an outer shell by screws while the bore is machined and an axial hole is drilled between each pad and the shell to receive a cylindrical pin. The screws and shims are then removed, leaving the pads free to rock on the pins to provide the desirable wedge-film clearance. The bearing design is especially effective in reducing low-frequency vibrations caused by dynamic instability in an oil film when rotational speeds are high and weights low. The patent has been assigned to Westinghouse Electric Corp. by Donald Bradbury.



VARYING CAPACITANCE between two metallic sleeves fastened to a torsionally loaded rotating shaft can be used to indicate the torque being transmitted. The two sleeves are insulated electrically from the shaft and are mounted on it at their outer ends only, so that any twisting of the shaft causes a relative angular displacement of the toothed, inner, opposed ends of the sleeves. The electrical capacity between the two sleeves is thus varied and can be detected quantitatively using an appropriate bridge circuit, giving a direct indication of the torque being transmitted by the shaft. The device, covered in patent 2,476,410 and assigned to General Motors Corp. by Arthur W. Gardiner, was first developed to enable aircraft pilots to obtain the same power output on each of several shafts, thereby utilizing fuel more efficiently.

LOCKING ACTION of an internally threaded pinion prevents spinning of a drive wheel in the differential mechanism described in patent 2,479,638, assigned to the Dualoc Engineering Co. by Ralph R. Randall. Input bevel gear is fastened to a housing or rotating gear carrier which contains two bearing plates that rotate with the carrier, a series of planet pinions, and an axle gear for each of the drive wheels.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ERIE specializes in bolts that depart from the standard in composition, heat treating, threading or size. We have been doing this specialized "bolting" work for 37 years for American Industry. Whatever your special bolt requirement from the husky hold-down alloy bolt or the close tolerance ground finish alloy steel Connecting Rod Bolts for Diesels to the smallest, ERIE is geared to meet your specifications. Send your blueprints today!

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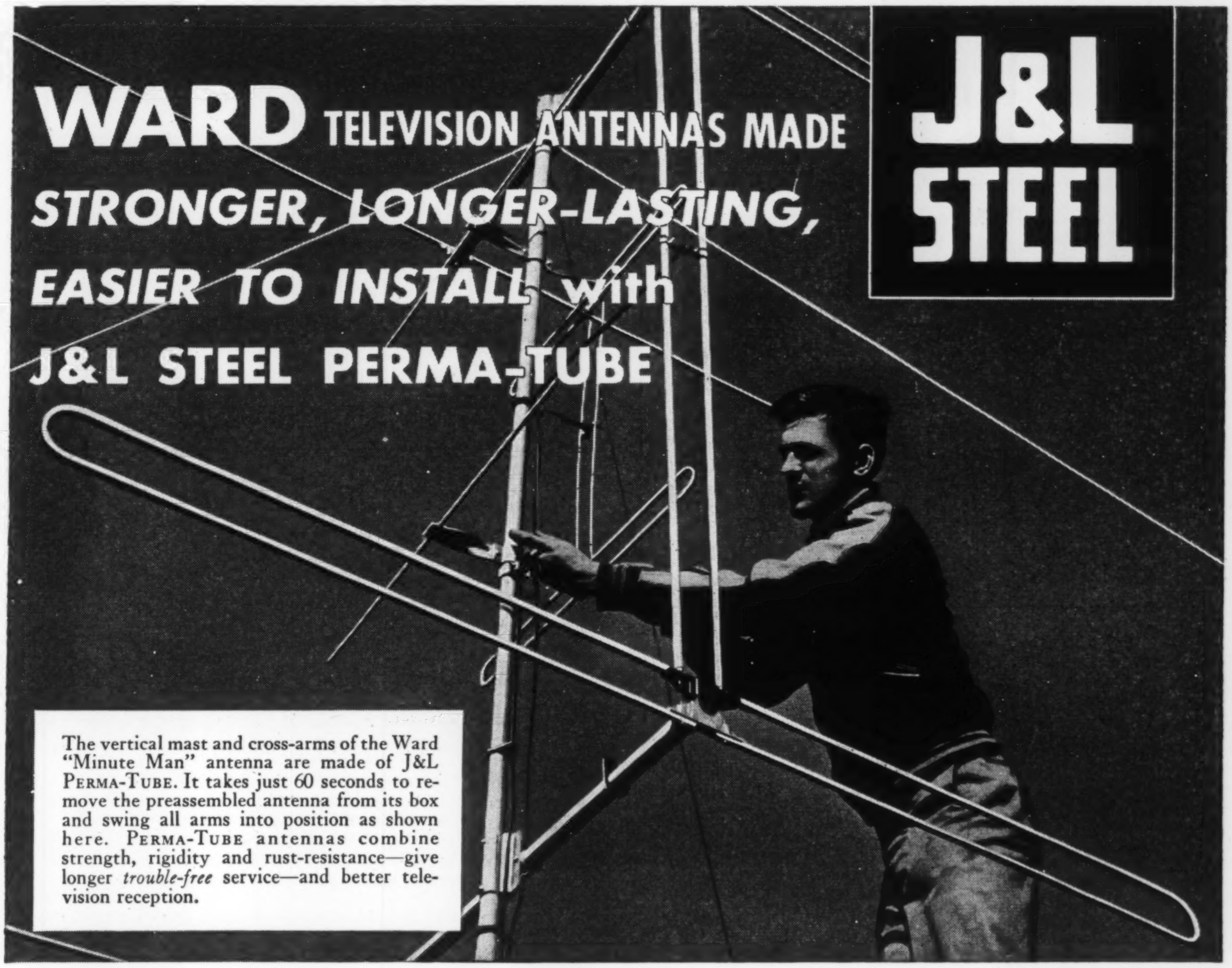
REPRESENTATION IN PRINCIPAL CITIES



The vertical mast and cross-arms of the Ward "Minute Man" antenna are made of J&L Perma-Tube. It takes just 60 seconds to remove the preassembled antenna from its box and swing all arms into position as shown here. Perma-Tube antennas combine strength, rigidity and rust-resistance—give longer *trouble-free* service—and better television reception.

PERMA-TUBE may be used for many applications where strength, rigidity, rust-resistance, and attractive appearance are necessary.

By using the new exclusive rust-resisting J&L Perma-Tube for the vertical mast and cross-arms in the "Minute-Man" series of television antennas, Ward Products Corporation, Division of the Gabriel Company, Cleveland, Ohio, builds-in the following advantages:

1. **Greater structural rigidity with smooth, attractive appearance. Greater strength to resist ice loads.**
2. **Clearer, steadier, television reception. Less vibration from wind.**
3. **No mechanical seam in Perma-tube to invite rust which would reduce the torsional strength.**
4. **Ease and speed of installation . . . at less cost.**

J&L Perma-Tube is a light-wall, electricweld steel tubing, coated inside and out with an exclusive plastic-type, weather-resistant finish. Perma-Tube can be furnished: bent . . . expanded . . . flanged . . . swaged or fluted.

J&L Perma-Tube for television antennas, *costs less than any other tubing with comparable strength, rigidity and rust-resistance.*

J&L Perma-Tube is not only applicable to television antennas, but also wherever strength, rigidity and rust-resistance are important. It is available in all regular sizes and shapes of J&L Electricweld Tubing and in lengths up to 10 feet. Return the coupon TODAY for complete information on this new J&L product.

Jones & Laughlin Steel Corporation
410 Jones & Laughlin Building
Pittsburgh 19, Pa.

Please send me complete information on the new J&L STEEL PERMA-TUBE mechanical tubing.

Do you recommend PERMA-TUBE for

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COMPANY______________________

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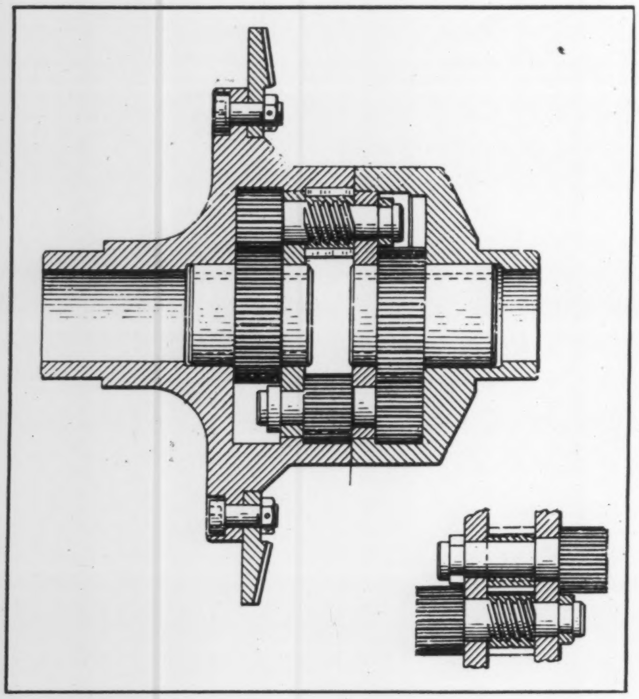
JONES & LAUGHLIN STEEL CORPORATION

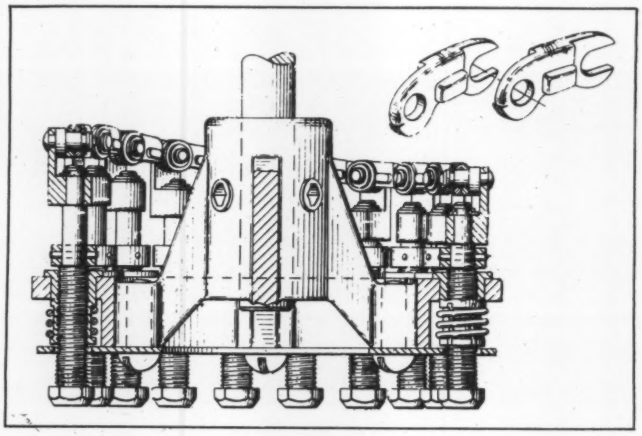
From its own raw materials, J&L manufactures a full line of carbon steel products, as well as certain products in OTISCOLOY *and* JALLOY *(hi-tensile steels).*

PRINCIPAL PRODUCTS: HOT ROLLED AND COLD FINISHED BARS AND SHAPES • STRUCTURAL SHAPES • HOT AND COLD ROLLED STRIP AND SHEETS • TUBULAR, WIRE AND TIN MILL PRODUCTS • "PRECISIONBILT" WIRE ROPE • COAL CHEMICALS

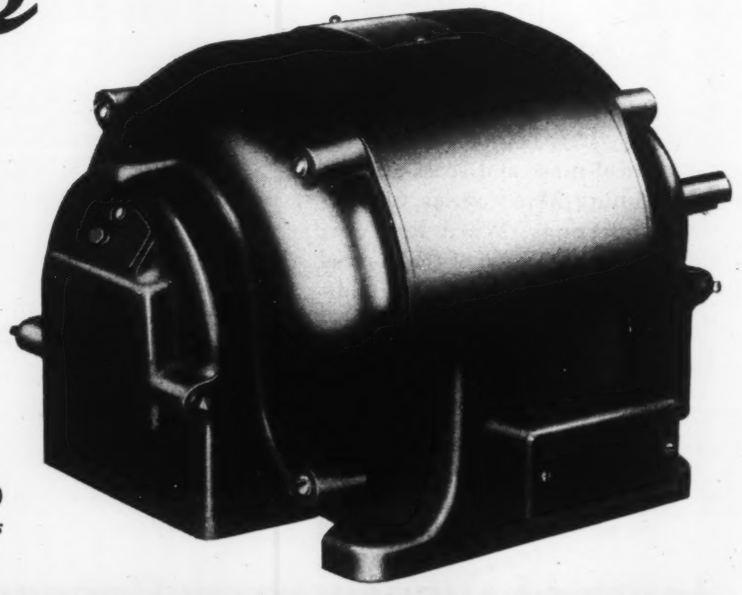


Supported between the bearing plates and geared to one of the axle gears are several screw threaded shafts each carrying an internally threaded pinion. Each threaded pinion, in turn, meshes with another pinion fixed to a parallel shaft which is geared to the second axle gear. Any appreciable difference in the torque delivered by the two drive wheels causes the screw threaded shafts to rotate, thereby moving the internally threaded gears axially until they clamp one or the other of the bearing plates, locking the entire gear train and driving both wheels.

ADJUSTABLE CAM TRACK made up of slotted links furnishes any desired profile in a mechanism patented by Otto Mohr and assigned to Bell Telephone Laboratories. Each link in the cam-track chain has one end secured to the upper end of a set screw or positioning rod, the slotted end being free to move on a pin fastened on the upper end of the adjacent rod. Vertical positioning of these threaded rods determines the cam profile. The device is described in patent 2,480,594.



HERE'S MOTOR EXPERIENCE THAT CAN BE *yours*

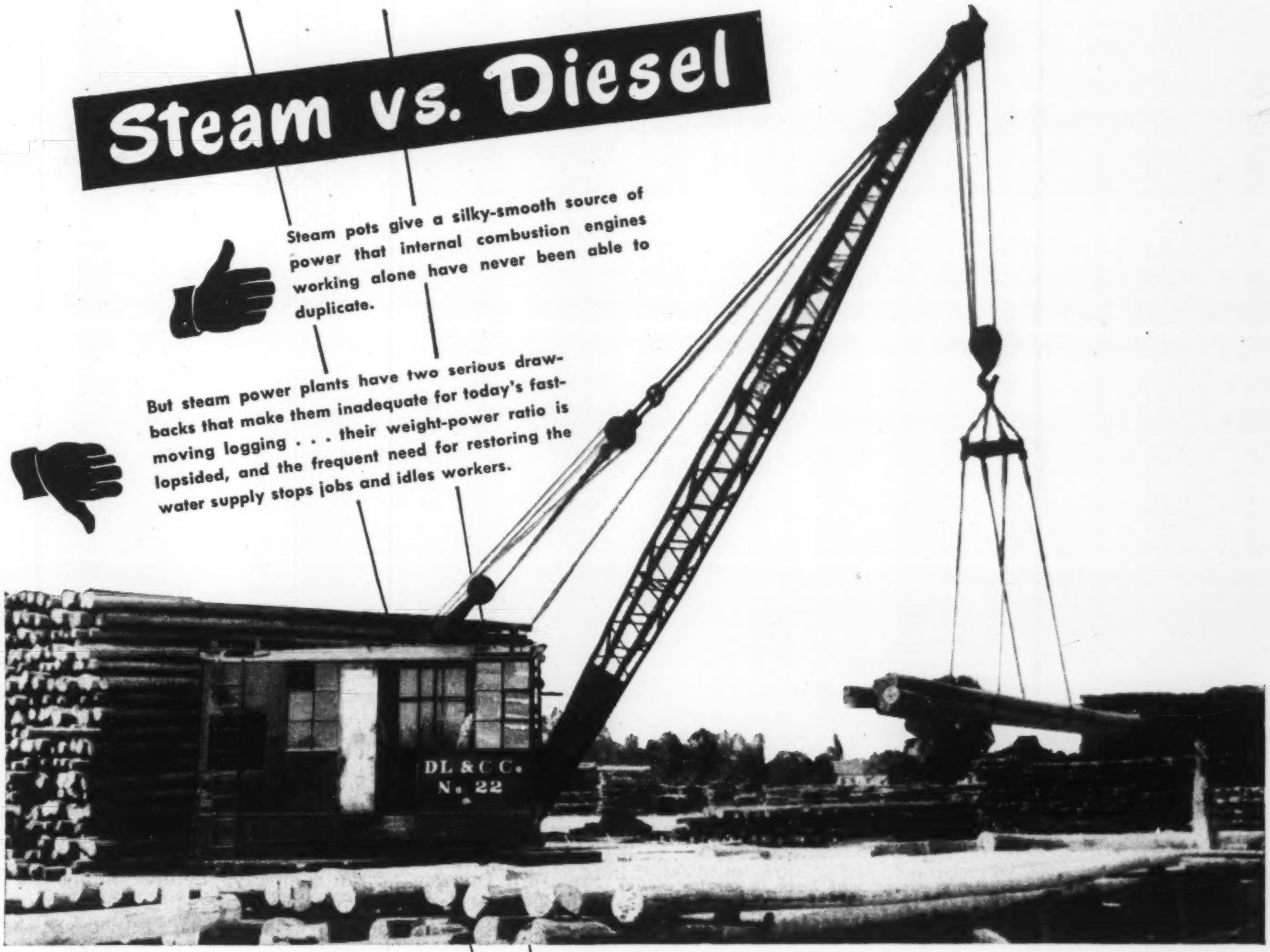


● A high percentage of all Peerless Motors are manufactured to meet the specific operating requirements of the equipment with which they are to be used. Answering these motor problems has given Peerless engineers an experience that can be yours when you call Peerless for advice on motor applications.

You will save time, energy and money by turning your motor problems over to Peerless. Call on us by telegram or telephone. Increased engineering and production facilities can be put to work for you promptly.

THE PEERLESS ELECTRIC COMPANY • WARREN, OHIO
Manufacturers of Quality Motors for more than 55 years
Single Phase • Polyphase • Direct Current Motors

ALL *Peerless Motors* ARE "PEERLESS REGISTERED"



Steam vs. Diesel

Steam pots give a silky-smooth source of power that internal combustion engines working alone have never been able to duplicate.

But steam power plants have two serious drawbacks that make them inadequate for today's fast-moving logging . . . their weight-power ratio is lopsided, and the frequent need for restoring the water supply stops jobs and idles workers.

How to Get

Steam Smooth Performance

from a

Diesel Engine

To combine the smooth power advantages of steam and the economy of Diesel power, Dierks Lumber and Coal Co., of De Queen, Ark., recently installed a Twin Disc Hydraulic Torque Converter (Lysholm-Smith type) in their 25-ton crane when they converted it to Diesel power.

The Orton crane now operates 16 hours a day with no interruptions. Except for a simple clutch lever on the torque converter, no original controls were added or changed. Besides providing steam power performance, the Twin Disc Torque Converter multiplies torque up to five times . . . enables the crane to push a 100-ton load with ease. Sluicing and road travel are smoother, faster, and there is less swing of the suspended load.

Ask your nearest Twin Disc dealer for details on converting steam to Diesel or gasoline power, or write Twin Disc today for Bulletin No. 135-C.

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin, (Hydraulic Division, Rockford, Illinois).

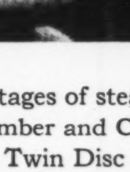
Hydraulic Torque Converter

Heavy Duty Clutch

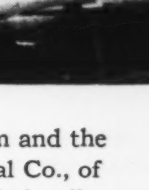
Machine Tool Clutch

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U. S. PAT. OFF.

Tractor Clutch



Marine Gear



SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

DC SILICONES Silicone News

Here's How DC Silicone Insulation Reduces Motor Failure

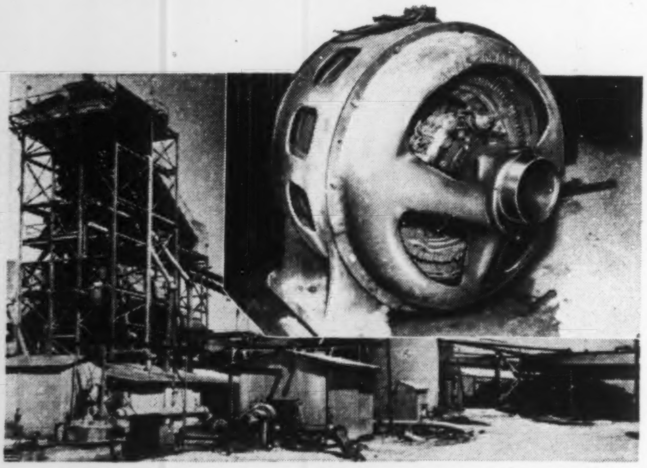


Photo courtesy Virginia-Carolina Chemical Corp.

THIS 300-H.P. silicone insulated motor was back in service three hours after being flooded with water, mud and waste.

• Engineers of Virginia-Carolina Chemical Corporation agree that DC Silicone Insulation is the best solution to motor failure caused by excessive moisture. They proved this in two identical 300-h.p. motors, one wound with Silicone (Class H) and the other with Class B insulating materials. Located side by side and exposed to the same operating conditions, these motors are used to pump waste materials at the Phosphate Mine in Homeland, Florida. After the main line broke last year and flooded both motors with water, mud and waste, the Class B motor had to be reworked and rebaked. The motor wound with Class H insulation was simply cleaned with an air hose and the bearings were flushed out . . . ***Three hours later, the SILICONE INSULATED motor was back in service and operating perfectly.***

That confirms again the fact established by 4 years of motor testing: Class H Insulation made with Dow Corning Silicones has at least 10 times the life and 10 times the wet insulation resistance of the best insulating materials previously available. For more information on how silicone insulated equipment can save you time and money, phone our nearest branch office or write for booklet W-12.

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Dow Corning FIRST IN SILICONES

SALES AND SERVICE PERSONNEL

THE NEWLY FORMED industrial division of Greer Hydraulics Inc., Brooklyn, N. Y., has been placed under the direction of **Michael Joseph Phillips,** new general manager. Mr. Phillips will supervise the production and marketing of Greer hydro-pneumatic accumulators and other hydraulic components for industry. He formerly was Commander of the Production Division, U. S. Navy Bureau of Aeronautics, assistant to the president of Jack & Heintz Precision Industries Inc., assistant chief engineer of Pesco Products and manufacturing vice president of Universal Business Machine Co.

◆

Formerly assistant district sales manager of the Chicago branch, mechanical goods division of United States Rubber Co., **Joseph A. Conlon** has been named to succeed **William T. Keenan,** who is retiring as district sales manager of the Chicago office.

◆

All sales operations for Yale & Towne Mfg. Co. trirotor pumps will be directed by **William D. Jameson,** who has recently been appointed sales manager of the Stamford Division of the company. Before joining Yale & Towne, Mr. Jameson was sales manager of Commonwealth Engineering Co. of Dayton, O. Previously, he was district sales engineer for Blaw-Knox Co., and prior to that he owned and operated Art-Lore Co., a small manufacturer of automobile accessories in New York City.

◆

The A. F. Holden Co. of New Haven, Conn. and Detroit has announced the appointment of **Lloyd J. Bohan** as West Coast representative. Mr. Bohan has been associated with the metal working industries for fourteen years and for the past two years has been a manufacturer's agent in southern California, specializing in heat treating equipment.

◆

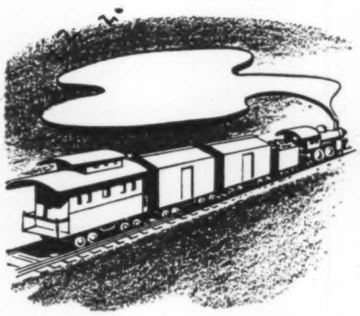
The Cooper Alloy Foundry Co., Hillside, N. J., announced recently the promotion of **Jack Victorine** and **Morton C. Meyers** to the position of general sales manager and assistant sales manager, respectively. Mr. Victorine has been connected with the stainless casting field at Cooper Alloy for the past seventeen years and has been sales manager for eight years. Mr. Meyers has been associated with the company for twelve years, serving as direct assistant to Mr. Victorine since 1945. Also, **J. L. Lessman** has been named to serve under Mr. Victorine as manager of valve and fitting sales.

◆

A. J. Jennings, vice president in charge of sales, the Cleveland Worm & Gear Co., Cleveland, and of its associate company, the Farval Corp., died following a heart attack October 30, 1949. Mr. Jennings began his business career with the E. F. Houghton Co. of Philadelphia. After fourteen years he left Houghton to become vice president and general manager of Lubrication Devices Inc. of Battle Creek, Mich., predecessor company

OSTUCO TUBING

speeds your deliveries 3 ways



1. Saves shipping time

Complete modern facilities for *manufacturing, shaping,* and *fabricating* tubing, all at one plant, make it unnecessary for you to have materials shipped from one supplier or one location to another.

2. Eliminates red tape

OSTUCO's "single source" operation puts an end to duplicate sets of instructions and similar time-consuming nuisances. You write one order, get one bill, and responsibility is clearly fixed.

3. Removes production snags

Your own manufacturing or assembly operations run more smoothly because OSTUCO's unified control of production greatly reduces number of rejects and assures highest quality all down the line.

By supplying you with the tubing you want *when you want it,* OSTUCO enables you to speed your own deliveries, keep your customers better satisfied, and operate with lower inventories.

Obviously too, OSTUCO's efficient "single source" operation is designed to cut your costs, thereby further strengthening your competitive position.

OSTUCO produces both seamless and electric-welded steel tubing in a broad range of sizes and shapes . . . meets your most exacting requirements in bending, reducing, expanding, flanging, upsetting, in fact all types of forging and fabricating operations. We are also in a position to supply the tubes painted or plated. An experienced OSTUCO Tubing Engineer will be glad to discuss your particular problems without obligation. Write direct or to our nearest Sales Office. Ask for new free booklet "Fabricating and Forging Steel Tubing."

OSTUCO TUBING

OSTUCO SHELBY OHIO

THE OHIO SEAMLESS TUBE COMPANY

Manufacturers and Fabricators of Seamless and Electric-Welded Steel Tubing

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Sales Offices: CHICAGO, Civic Opera Bldg., 20 North Wacker Dr. • CLEVELAND, 1328 Citizens Bldg. • DAYTON, 511 Salem Avenue • DETROIT, 2857 E. Grand Blvd. • HOUSTON, 6833 Avenue W, Central Park • LOS ANGELES, Suite 300-170, So. Beverly Drive, Beverly Hills • MOLINE, 617 15th St. • NEW YORK, 70 East 45th St. • PHILADELPHIA, 1413 Packard Bldg., 15th & Chestnut • ST. LOUIS, 1230 North Main St. • SEATTLE, 3104 Smith Tower • SYRACUSE, 501 Roberts Ave.
CANADIAN REPRESENTATIVE: Railway & Power Corp., Ltd., NEW GLASGOW, MONTREAL, NORANDA, NORTH BAY, TORONTO, HAMILTON, WINDSOR, WINNIPEG, EDMONTON, VANCOUVER

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solves many problems

caused by sliding or rotating parts which are difficult or impossible to lubricate

A constantly increasing stream of problems are facing engineers and designers today involving sliding or rotating parts where lubrication is difficult or impossible. For such applications, Purebon, the mechanical carbon, is often the ideal answer. Typical applications are seal rings, bearings, pistons, piston rings, pump vanes, valve seats, meter discs, and a host of similar items. Purebon comes in a wide variety of grades. It is strong, tough, readily machineable and in many cases can be molded directly to size.

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PURE CARBON CO., INC.

446 HALL AVE. ST. MARYS, PA.

to the Farval Corp. He came to Cleveland in 1932 when Farval was purchased by the Cleveland Worm & Gear Co. As one of the early and most active figures in the American Society of Lubrication Engineers, Mr. Jennings served on its committees and delivered many papers before the national meetings of the Society. He was also active in the American Gear Manufacturers Association, serving at the time of his death as Chairman of the General Commercial Committee.

◆

President of the National Screw & Mfg. Co., Cleveland, **H. P. Ladds** has been elected to the board of directors of Lock Thread Corp., Detroit.

◆

Max L. Murdock, acting manager of the centrifugal pump department at Allis-Chalmers Norwood, O., works, has been promoted to manager of the department succeeding **H. C. Gaton**, who has retired. **Woodrow Brixius**, formerly application engineer in the company's West Allis works centrifugal pump department, has been named assistant to Mr. Murdock, and **Paul B. Hugenberg** has been appointed application engineer in charge of sales and orders.

◆

With headquarters at York, Pa., **S. J. Woodworth** has been appointed sales manager of the Wright Hoist division of American Chain & Cable Co. Inc. He has been with the division for over twenty-five years and has had wide experience with hoisting applications and materials handling problems.

◆

Election of **Raymond Z. Oswald** as vice president in charge of replacement sales of the Cleveland Graphite Bronze Co. was announced recently. He has been in the automobile parts sales field for twenty-four years and was president of Monmouth Products Co. when that company was purchased several months ago by Cleveland Graphite Bronze. Monmouth business is now conducted as the Monmouth Products Division of the Cleveland Graphite Bronze Co. **Gilbert M. Salzman** is manager of the division; **James E. Bradley** is sales manager; and **Albert M. Currier Jr.** is assistant sales manager.

◆

Spencer R. Griffiths has been appointed assistant sales manager of Unistrut Products Co., Chicago. He was formerly associated with Joseph T. Ryerson and Son Inc., in charge of stainless steel sales in the Midwest.

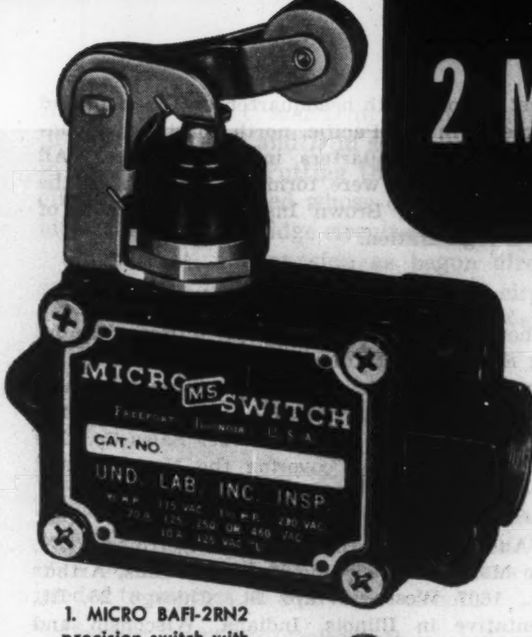
◆

Newly elected vice president and manager, chain and transmission division of Chain Belt Co., **William J. Sparling** has been with the company since 1928. Until 1934 he was in charge of the metallurgical laboratory, then was appointed assistant to the chief engineer of the chain and transmission division, a position which he held until he was made assistant works manager. Mr. Sparling has served as works manager for the past four years. **E. P. Meyer** succeeds Mr. Sparling as works manager, having previously held the position of assistant works manager.

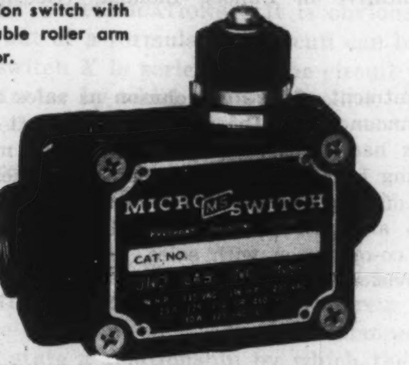
◆

Belfield Valve division of Minneapolis-Honeywell Regulator Co. is adding to its field sales staff in a new and expanded sales and manufacturing program. Those assigned to full time on regional valve sales are: **Russell A. Schlegel** for the eastern region, with headquarters in New York; **George Brown** for the central region, with headquarters in Cleveland; **Robert Scott** in the midwest

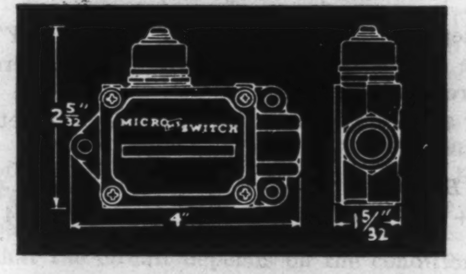
2 MICRO Precision Switches...



1. **MICRO BAFI-2RN2 precision switch with adjustable roller arm actuator.**



2. **MICRO BAFI-2RN precision switch with plunger actuator. Both switches are available in both right and left hand designs.**



Combining High Electrical Rating with High Inrush Capacity

These two MICRO precision switches offer the design engineer the answer to applications which call for a steady state current rating of 20 amperes and an inrush capacity of 75 amperes at voltages up to 460 volts a-c.

Available with both plunger and adjustable roller arm actuators, these switches are sealed in rugged die cast aluminum housings to protect against mechanical damage or shock. Overtravel mechanism is built into the metal housing. Ample wiring space is provided in the housing. Side facing terminals on the enclosed basic switch simplify wiring.

Underwriters' Laboratories list these two switches for ¾ H.P., 115 volts a-c; 1½ H.P., 230 volts a-c; 20 amperes, 125, 250 or 460 volts a-c; tungsten lamp, 10 amperes, 125 volts, a-c.

These two switches are typical of MICRO'S continual effort to develop new precision switches to meet every type of design requirement. They are but two of more than 3900 varieties of MICRO precision switches. Whatever your design problem, if it involves the use of precision snap-action switches, consult MICRO SWITCH engineering service direct or contact any of the offices listed. It may save you time and money.

MICRO...
first name in
precision switches

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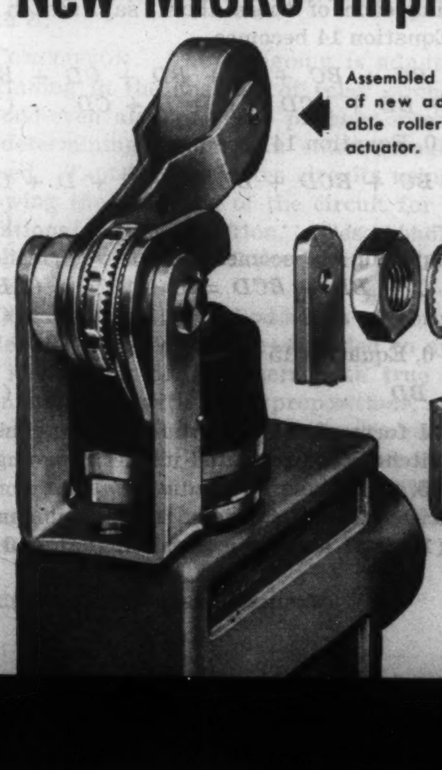
MICRO SWITCH
TRADE MS MARK ®
A DIVISION OF FIRST INDUSTRIAL CORPORATION
FREEPORT, ILLINOIS, U.S.A.

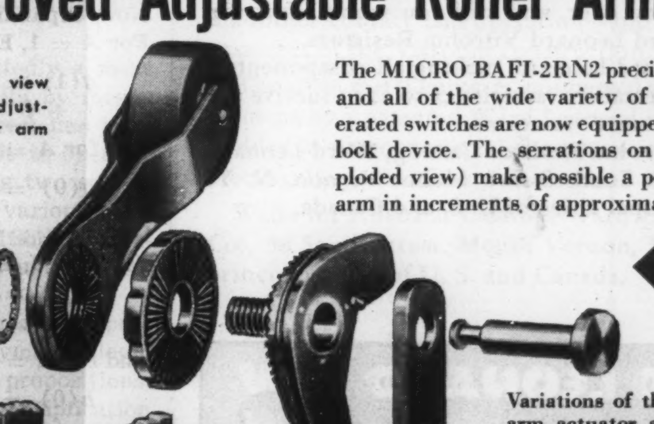
BRANCH OFFICES: Chicago · New York · Boston · Cleveland · Los Angeles
SALES REPRESENTATIVES: Portland · St. Louis · Dallas · Toronto

New MICRO Improved Adjustable Roller Arm Actuator



Assembled view of new adjustable roller arm actuator.

The MICRO BAFI-2RN2 precision switch shown above and all of the wide variety of MICRO roller arm operated switches are now equipped with this new positive lock device. The serrations on the roller arm (see exploded view) make possible a positive lock of the roller arm in increments of approximately .2°.

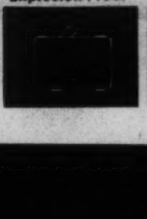


Exploded view of new adjustable roller arm actuator showing serrations which give positive-lock in all positions.

Variations of this new adjustable roller arm actuator are now standard on all types of MICRO precision switches which employ a roller arm actuator. These include the following:

Micro-Limit

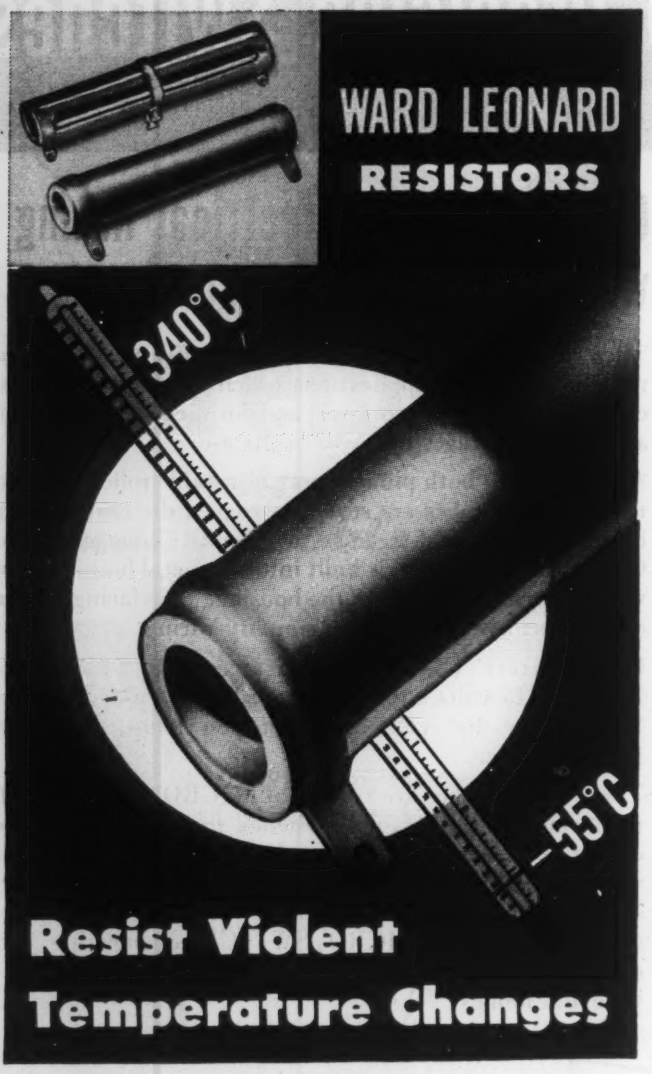
LMR Rotary



Explosion Proof

Die Cast Enclosed

Splash Proof



because all parts are
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Switch the temperature back and forth from 340 to —55°C, over and over, and still you won't affect the stability of Ward Leonard Vitrohm Resistors.

Reason is: Ward Leonard, making all components*, can control thermal characteristics so as to survive the greatest temperature variations.

Write for Vitrohm Resistor Catalog, Ward Leonard Electric Co., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

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RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

and northwest regions, with headquarters in Chicago; and **William Clements** in the Pacific, north coast and mountain regions, with headquarters in Los Angeles. All of these new appointees were formerly members of the field sales staff of the Brown Instruments division of the Honeywell organization.

◆

In an announcement made recently, **Marlowe Young** of Soldering Specialties, 19 Chatham Rd., Summit, N. J., announced new regional representatives to handle sales of all Soldering Specialties products. Newly appointed representatives are: **Harry Gerber,** Gerber Sales Co., 739 Boylston St., Boston, Mass., covering the New England area; **Harry C. Stockfleth,** 10 Lake Rd., Chatham, N. J., whose territory is the New York metropolitan area; **Harold F. Anderson** 960 Harper Ave., Detroit, Mich., covering the Michigan area; and **Arthur J. Ellis,** Arthur J. Ellis Co., 1607 West Harvard St., Chicago 26, Ill., the representative in Illinois, Indiana, Wisconsin and Iowa.

◆

The appointment of **Walter Johnson** as sales manager has been announced by the George K. Garrett Co. Mr. Johnson has had extensive experience in the metal industry, having been with leading steel companies on the West Coast for many years. He came to the Garrett Co. in 1941 and since then has held various positions working in co-operation with sales, production and procurement divisions.

Relay Circuit Analysis

(*Continued from Page* 139)

as $f(X)$. Then $f(1) = Y$ and $f(0) = Y + 1 = Y'$. Putting these results into the circuit of *Fig.* 4, there results the circuit of *Fig.* 2.

Consider also Equation 10 as $f(X)$. Then by letting $X = 1$

$$f(1) = BC + ABC + AD + ABD + ACD + BCD + AC + BD + ABCD \quad \ldots\ldots\ldots\ldots (14)$$

By letting $X = 0$

$$f(0) = AC + BD + ABCD \quad \ldots\ldots\ldots\ldots (15)$$

Now expanding each of these about, say, switch A: For $A = 1$, Equation 14 becomes

$$g(1) = BC + BC + D + BD + CD + BCD + C + BD + BCD = C + D + CD \quad \ldots (16)$$

and for $A = 0$, Equation 14 becomes

$$g(0) = BC + BCD + BD = B(C + D + CD) \quad \ldots\ldots\ldots\ldots (17)$$

for $A = 1$, Equation 15 becomes

$$h(1) = C + BD + BCD = C + BD + C(BD) \quad \ldots\ldots\ldots\ldots (18)$$

and for $A = 0$, Equation 15 becomes

$$h(0) = BD \quad \ldots\ldots\ldots\ldots (19)$$

The general form of the circuit for the expansion about two switches, as illustrated in the foregoing, is given in *Fig.* 5.

By comparison with definitions 3 and 4 it can be seen that $g(1)$ is C and D in parallel, that $g(0)$ is

B in series with C and D in parallel, that $h(1)$ is C in parallel with B and D in series and that $h(0)$ is B in series with D. Putting these values into *Fig.* 5 a circuit can be derived whose openness and closure is identical with the bridge circuit of *Fig.* 3.

By successive expansion as begun already for X and A, it can be seen, *Fig.* 6, that any circuit having N switches can be expressed as an equivalent circuit having at most S switches where

$$S = 2 + 4 + 8 + 16 + \ldots + 2^n = 2^{n+1} - 2 \qquad \ldots\ldots\ldots (20)$$

or by using three-way switches for pairs of complementary switches, any circuit can be expressed by using not more than $2_n - 1$ three-way switches. In general, of course, all the possible switches will not be needed to express an equivalent circuit.

CIRCUIT SIMPLIFICATIONS: It is obvious that, if X factors out of a formula, the circuit can be expressed as the switch X in series with the circuit represented by the factor by which X is multiplied. This fact is expressed in the following theorem:

> *Theorem* 3: If $f(0) = 0$, then $f(X) = Xf(1)$ and the circuit can be expressed by switch X in series with $f(1)$

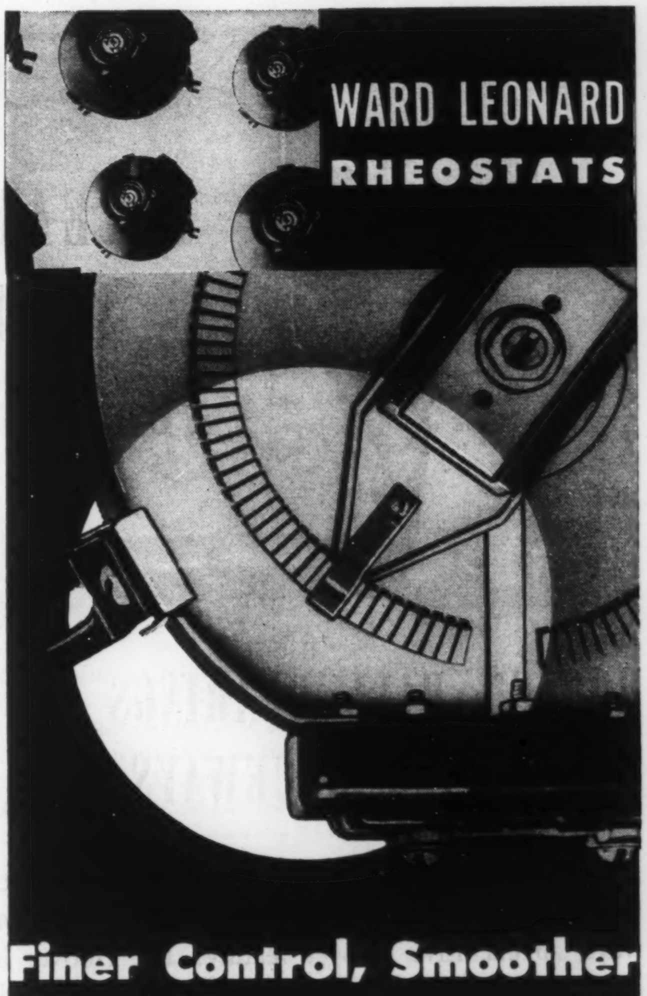
The first part of Theorem 4 follows from Theorem 1, and the second conclusion of Theorem 4 is a consequence of definition 3. In a like manner it is possible to state a relationship by which the entire circuit can be expressed as a circuit in parallel with switch X, viz:

> *Theorem* 4: If $f(1) = 1$, then $f(X) = X + (X + 1)\,f(0) = X + f(0) + Xf(0)$, and the circuit can be expressed by switch X in parallel with $f(0)$

To illustrate Theorem 4, consider a circuit made up of several positions of switches A and B, as given in *Fig.* 7. For $A = 1$, it is seen that the circuit would be closed, so that $f(1) = 1$. For $A = 0$, it is seen that the circuit depends on the condition of the lowest B switch, so that $f(0) = B$. Thus Theorem 4 states that the circuit is equivalent to A in parallel with B.

CONCLUSION: The foregoing is admittedly a mere beginning in the analysis of relay circuits by means of odd-even algebra. The primary interest has been in determining whether an entire circuit is open or closed. TABLE 1 illustrates circuits using two relays, showing the condition of the circuit for various combinations of relay position. These conditions are established by the use of the formulas included in the table.

Other applications of odd-even algebra appear possible. The system can be extended to symbolic logic by identifying odd numbers with true propositions, even numbers with false propositions, multiplication with the "and" function and, finally, identifying "or" with the $X + Y + XY$ relationship defined in this article for two switches in parallel. The study of the foregoing theory has been found useful for solving circuit problems.



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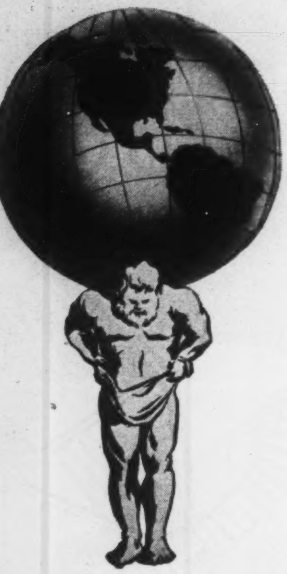

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SALES NOTES

MANUFACTURERS and fabricators of laminated phenolic plastics for industry, **Synthane Corp.** of Oaks, Pa. has moved its Chicago sales offices to larger quarters and a more convenient location at Morton Grove, Ill., in the growing industrial area northwest of Chicago. The company has leased and equipped a modern building, combining stock warerooms and offices. Ellis W. Croisant is Chicago district sales manager.

◆

Commercial Filters Corp. of Boston, Mass., manufacturers of filters and cartridges for the microscopic filtration of all industrial and commercial fluids, has opened a Midwestern sales office at 603 West Washington Blvd., Chicago, Ill. The new office will be under the direction of Walter H. Magee.

◆

Two new distributors for the state of California have been appointed by the **Flexitallic Gasket Co.** of Camden, N. J. **Power Engineering and Equipment Co. Inc.**, 131 North Marine Ave., Wilmington, Calif., will serve southern California, and the northern section of the state will be served by **Transmission Engineering Co.**, 53 Stevenson St., San Francisco 5, Calif. The Flexitallic Gasket Co. has also appointed **Tube Engineering and Service Co. Ltd.**, 2052 St. Catherine St., W., Montreal, Canada, as distributor for all Canadian provinces east of Manitoba.

◆

The name of Dohner & Lippincott, industry designers, has been changed to **Lippincott & Margulies.** The offices of the company are located at 500 Fifth Ave., New York 18, N. Y.

◆

A partnership has been formed for the purpose of helping builders of machinery, equipment and technical products in their management, distribution and sales problems. The partnership combines the experience and facilities of Bernard Lester, sales management engineer and formerly manager resale department of Westinghouse Electric Corp.; Frank W. Hankins, industrial sales and marketing counsellor of Hankins-Borie

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LOW COST
TIGHT SEAL
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Uniflare

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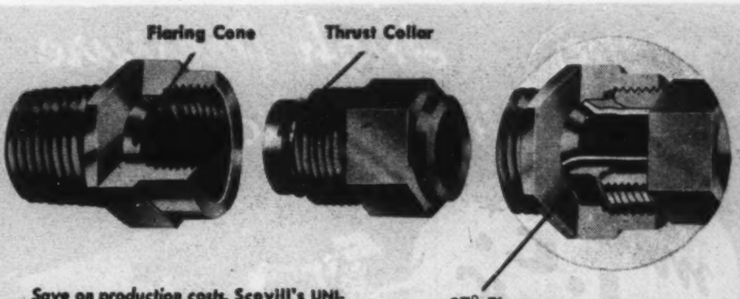
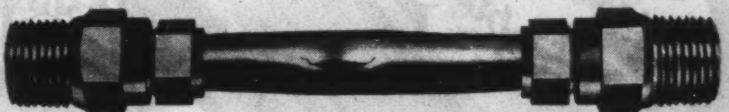


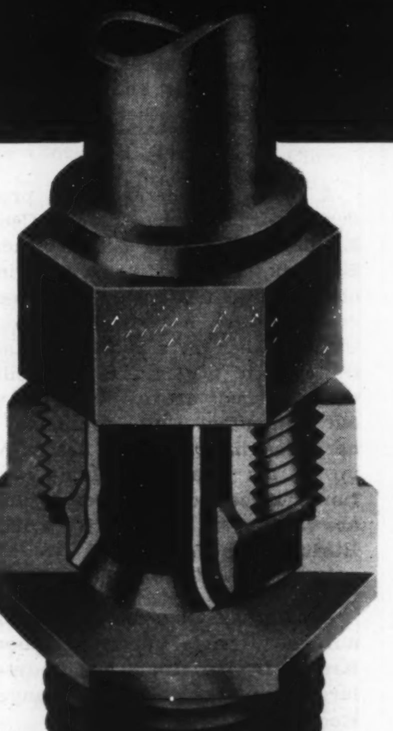
Save on production costs. **Scovill's UNIFLARE is two-piece fitting that is *self-flaring.* No preliminary flaring operation—no flaring tools needed—no tube cracking that sometimes accompanies flaring. And you can use lighter, less costly tubing.**

Assure tighter seal. **Scovill's UNIFLARE makes the recommended 37 degree flare without weakening the tube. Special brass alloy permits more tightening.**



Provide greater strength. **Scovill's UNIFLARE has triple the strength of a compression fitting. Exhaustive pressure tests prove that the tube will burst (but not at the joint) before the UNIFLARE fitting will leak. The assembly illustrated above was subjected to such a test.**

Allow for frequent disassembly. **Scovill's UNIFLARE can be taken apart and reassembled many times without weakening the seal.**



UNIFLARE is available in a complete range of sizes for tubing ⅛ in. through 1 in. O. D. and in all standard shapes. Fully tested and approved by the Underwriters' Laboratories, Inc.

You can safely specify UNIFLARE for refrigeration, etc. The inverted flare and taper of nut thread toward wrench end help keep out condensate.

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One turn of the nut shears off the thrust collar, clamping it onto the tube; further tightening forces the tube over the flaring cone and makes the seal. No flaring tools needed . . . no separate flaring operation . . . no cracked tubing to worry about.

Investigate UNIFLARE for oil, air, water or hydraulic lines. Write on company letterhead for a working sample. Address Screw Machine Products Division, SCOVILL MANUFACTURING COMPANY, 50 Mill Street, Waterbury 91, Conn.

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All Miller Standard High Pressure Hydraulic Cylinders met both the *mandatory* and *recommended* practices of the "Standards" *years ago.*

Some "Standards" specifications, such as dirt protectors, scratch-resistant piston rods, etc., are required only under severe conditions. *All* Miller *Standard* High Pressure Hydraulic Cylinders met *these* requirements *years ago.*

The desire for elimination of *manual* rod seal adjustment is strongly voiced at all hydraulic industry conferences. The *"time tested and proven"* Miller Patented Rod Seal is self-adjusting and wear compensating . . . *requires no manual adjustment.*

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and Associates; and John A. Silver, former executive vice president and director of F. J. Stokes Machine Co. Offices of the new **Lester, Hankins and Silver** company are at 1605 Race St., Philadelphia 3, Pa. and 140 Cedar St., New York 6, N. Y.

◆

The **Holden Co. Ltd.** of Montreal has been appointed exclusive Canadian sales agent for seamless flexible metal hose manufactured by the Eclipse-Pioneer division of **Bendix Aviation Corp.** The appointment of the Canadian agency is expected to effect economies for customers in Canada and to expedite routine sales and service functions. In addition, factory-trained experts will be readily available for consultation on problems involving the use of flexible metal hose.

◆

The Los Angeles branch office of the **Rucker Co.** has been moved to larger, more modern quarters at 1855 Industrial St., Los Angeles, Calif. This company is exclusive distributor for Denison, Dudco and McIntyre hydraulic fluid pumps, motors and valves, Modernair and Hanna cylinders and many other leading lines.

◆

A new engineering and product design organization called **Century Engineers Inc.** has been formed in Burbank, Calif. Century Engineers offers companies lowered engineering costs through a pool of engineering talent, either on a full-time basis or for specific projects. Shop facilities, when needed, are available to work out manufacturing problems and carry engineering and design work up to the point of volume production. Offices of the new company are located at 204 North Parish St., Burbank, Calif.

◆

Because of increasing demand for automatic parts handling equipment **Kraus Design Inc.**, has moved to larger quarters at 950 Exchange St., Rochester 8, N. Y.

◆

Two exclusive representatives for the company's air and hydraulic cylinders and special machinery have been appointed by the **Hydro-Line Mfg. Co.**, Rockford, Ill. They are **Austin-Hastings Co. Inc.**, 226 Binney St., Cambridge, Mass., covering all the New England states except Connecticut; and **Hydro Pneumatics Inc.**, 95 Liberty St., New York, N. Y., with the territory of metropolitan New York and northern New Jersey.

MEETINGS

AND EXPOSITIONS

Dec. 19-21—

American Society of Agricultural Engineers. Winter meeting to be held at the Stevens Hotel, Chicago, Ill. Raymond Olney, P. O. Box 229. St. Joseph, Mich., is secretary.

Jan. 9-13—

Society of Automotive Engineers. Annual meeting and engineering display to be held at the Book-Cadillac Hotel, Detroit, Mich. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Jan. 11-13—

Society of Plastics Engineers Inc. Annual technical conference to be held at the Hotel Carter, Cleveland, Ohio. Mrs. Bess R. Day, 409 Security Bank Bldg., Athens, Ohio, is executive secretary.

Jan. 16-19—

Plant Maintenance Show to be held in the Cleveland Auditorium, Cleveland, Ohio. Additional information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Jan. 23-26—

Institute of Aeronautical Sciences. 18th annual meeting to be held at the Hotel Astor, New York, N. Y. Robert R. Dexter, 2 East 64th St., New York 21, N. Y., is secretary.

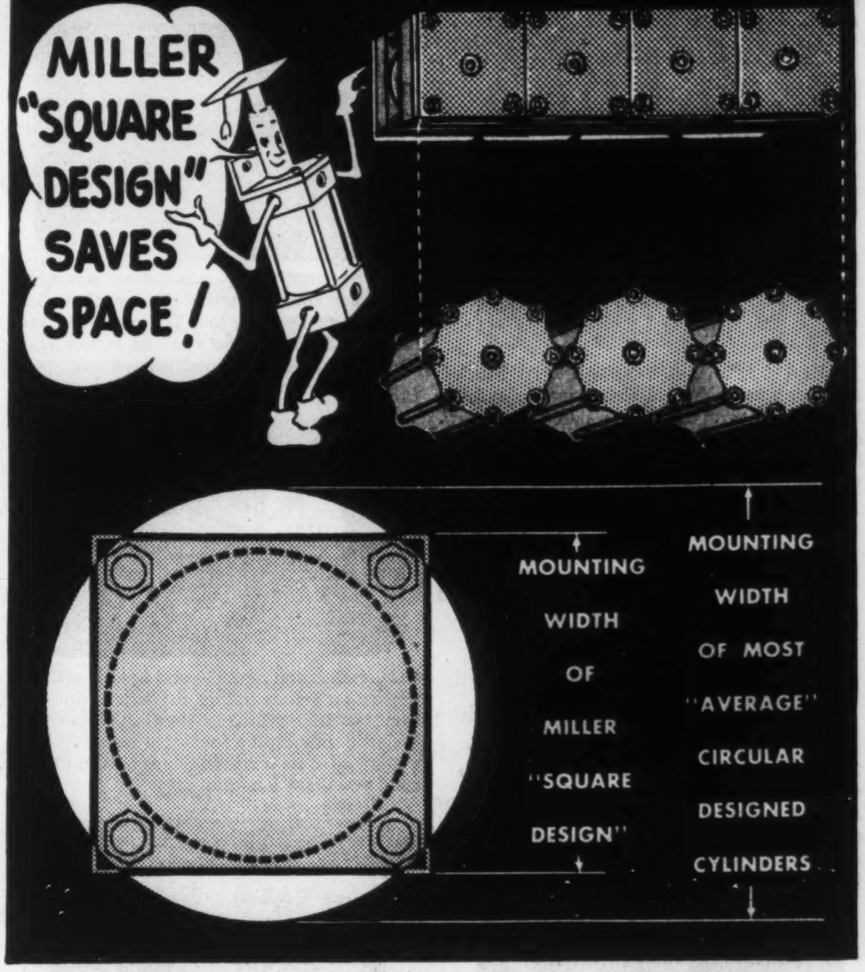
Jan. 23-27

American Society of Heating and Ventilating Engineers. Fifty-sixth annual meeting and the Southwest Air Conditioning Exposition to be held in Dallas, Texas. A. V. Hutchinson, 51 Madison Ave., New York 10, N. Y., is secretary of the society and Charles F. Roth, Grand Central Palace, New York 17, N. Y., is exposition manager.

Feb. 12-16—

American Institute of Mining & Metallurgical Engineers. Annual meeting of the Iron and Steel Division, the Institute of Metals Division and the Extractive Metallurgy Division in connection with general meeting of AIME to be held at the Hotel Statler, New York, N. Y. Ernest Kirkendall, 29 West 39th St., New York 18, N. Y., is secretary.

Miller Air Cylinders Hydraulic Cylinders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Other Outstanding Miller Standard Features . . .

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Single and Double Acting, Single and Double Rod End, Spring Return, Cushioned and Non-Cushioned, Over-Sized Rod, and Long Stroke Cylinders in All Mounting Styles.

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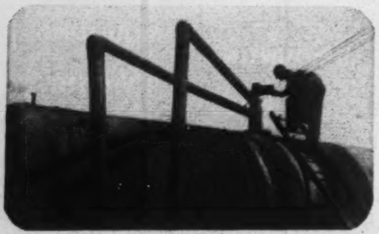
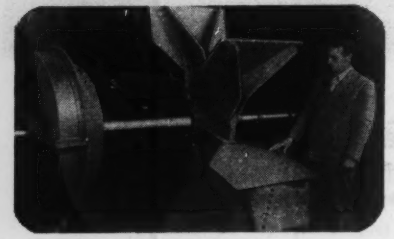
1. "HEAT . . . WHERE YOU WANT IT" is the name of a new General Electric sound slidefilm on industrial electric heaters. It covers dozens of cost-cutting opportunities for electric heat, as in the crank-case cleaner (above) where . . .



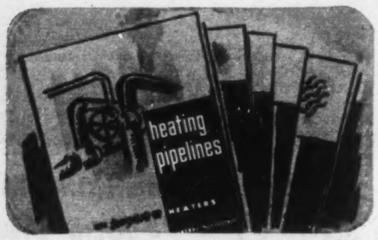
2 . . . a built-in immersion heater was used to supply the hot oil needed to do the job right. Another place where electric heat had to make oil "keep moving" was in the feed lines of this fuel-storage tank (above). But the big opportunity for electric heat is in . . .



3 . . . heating surfaces which, in turn, heat something else. Typical of the applications shown in the film is this sludge-drying fan (above) where electric heaters are clamped between the blade sections. A simple application, yet completely effective!

4. If you want to dry, bake, cure, warm, or ripen something, there's plenty of visual data on air heating, too. You can even see how it's done "on the run" as in this continuous air-heating tunnel (above). Or, possibly you'd like to . . .

5 . . . melt a soft metal—and keep it melted, the way it's done in this automatic can-soldering machine (above). "Heat . . . Where You Want It" has all the facts you need. To convince you of its worthwhileness, we'd like to send you these 5 helpful . . .



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GENERAL ELECTRIC

Feb. 27-Mar. 3—

American Society for Testing Materials. Spring meeting to be held at the Hotel William Penn, Pittsburgh, Pa. Robert J. Painter, 1916 Race St., Philadelphia 3, Pa., is assistant to the secretary.

Mar. 14-16—

Society of Automotive Engineers. Passenger car, body and production meeting to be held at the Book-Cadillac Hotel, Detroit, Mich. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Mar. 28-31—

Society of the Plastics Industry. Fourth national plastics exposition to be held at the Navy Pier, Chicago, Ill. William T. Cruse, 295 Madison Ave., New York 17, N. Y., is executive vice president.

Apr. 4-8—

National Production Exposition sponsored by the Chicago Technical Societies Council will be held at the Stevens Hotel, Chicago, Ill. John C. Toohy, 176 W. Adams St., Chicago 3, Ill., is exhibit manager.

Apr. 10-14—

American Society of Tool Engineers. Industrial exposition to be held at Convention Hall, Philadelphia, Pa. Additional information may be obtained from John M. Cannon, Director of Public Relations, 10700 Puritas Ave., Detroit 26, Mich.

Apr. 17-19—

Society of Automotive Engineers. Aeronautic meeting and aircraft engineering display to be held at the Statler Hotel, New York, N. Y. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

May 8-12—

American Textile Machinery Exhibition to be held in Atlantic City Auditorium, Atlantic City, N. J., under the sponsorship of the National Association of Textile Machinery Manufacturers. E. Kent Swift, Whitinsville, Mass., is president.

June 11-15—

American Electroplaters' Society. 37th annual convention to be held at the Hotel Statler, Boston, Mass. The Fourth International Electrodeposition Conference in collaboration with the Electrodepositors' Technical Society of England will be held at the same time. Additional information may be obtained from American Electroplaters' Society, 473 York Rd., Jenkintown, Pa.

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In other words, we don't go by guesswork . . . when we accept an order, the customer can rest assured of completely satisfactory results.

The metal powder process offers important savings and mechanical advantages to the user of a large volume of finely finished parts built to close commercial tolerances. You are invited to consult with our engineers, who will definitely determine whether powder metallurgy can benefit you as it has benefited many.

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Competition is returning. Up-to-date engineering can be *important to you!*

- LOW FRICTION
- ELIMINATE BINDING AND CHATTER
- SOLVES SLIDING LUBRICATION PROBLEMS
- LASTING ALIGNMENT
- LOW MAINTENANCE
- LONG LIFE

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Now in production for ¼", ½", ¾", 1" and 1½" shaft diameters. If you have a catalog, phone your representative or write us for new Data Sheet. If not, write for complete literature and the name of our representative in your city.

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DESIGN ABSTRACTS

High-Compression-Ratio Engine Tougher To Make

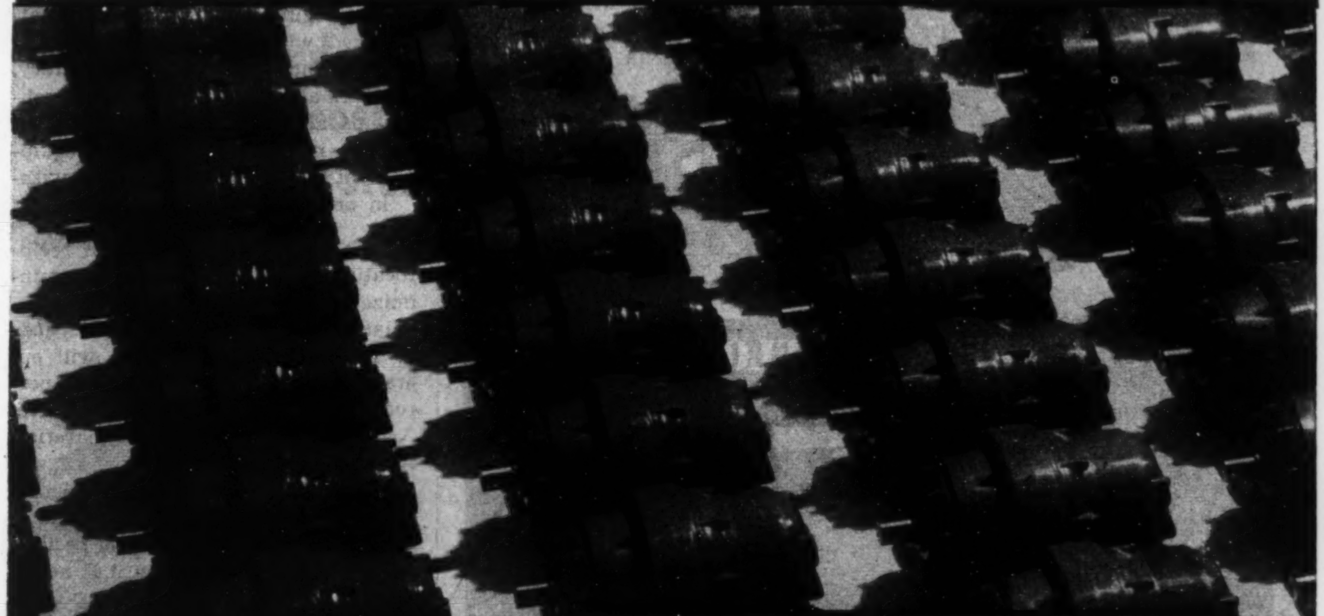
HIGH-SPEED engines capable of withstanding compression ratios of 10 to 1 impose many production problems. This type of engine inherently involves closer machining tolerances and more exacting manufacturing and inspection procedures.

Speculation has it that such engines will be shorter in overall length and height, of more sturdy construction, and will have a stroke-to-bore ratio of about one. These factors tend to facilitate machining. The main and connecting rod bearings will be larger to withstand the heavier loads. The main crankshaft and connecting rods probably will be forged to get the necessary rigidity characteristics.

Change-over to this high-compression type of engine will require the following changes, tightening up present production standards:

1. Barring major advances in valve seat milling machinery, it probably will be necessary to lap all seats to the respective valves. Present machinery cannot mill or check valve seats to less than 0.004-in. total eccentricity with the valve stem guide
2. Main and connecting rod bearings should be machined with a maximum taper and out-of-round of 0.0002 to 0.0003-in.—average present standard being 0.0003 to 0.0004-in.
3. Connecting rods should be held within ±0.005-lb on each end, providing a total tolerance of 0.020-lb on the net weight. This will require special machinery which is under development, but not presently used in production by any manufacturer. Best tolerance obtainable today is about ±0.0075-lb
4. Pistons also will have to be machined to correspondingly low weight tolerances of ±0.004-lb. This tolerance should not impose the problem that the connecting rod limit does because we already have equipment able to hold this limit on a production basis
5. Weight of piston and connecting rod assembly will be held to the lowest amount commensurate with required strength, which means that the pistons probably will be made of aluminum alloy. Costs of

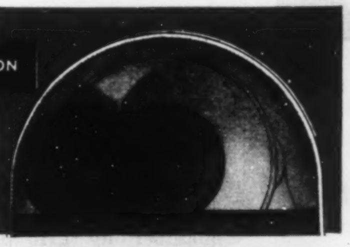
GEARED POWER for multiplied Torque



U.S. SYNCROGEAR

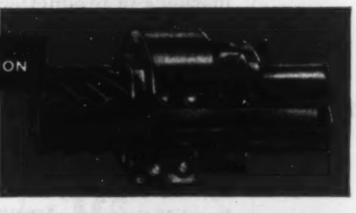
THE GEARED MOTOR WITH PYRAMIDAL STABILITY WITH ENCLOSED GEARS DESIGNED FOR ANY SPEED

PRECISE LUBRICATION



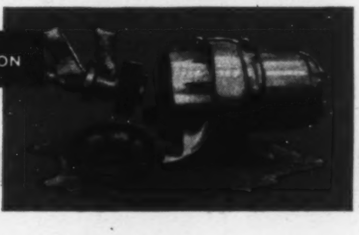
Gear-dip lubrication prevents excess churning of oil. Supplies proper amount of lubrication. Keeps oil cool.

SOLID SHANK PINION



King-size shank with integral teeth gives pinion extra strength. Prevents rapid wear. Avoids distortion.

EASIEST INSPECTION



End bells can be removed for quick inspection of gears, bearings and oil reservoir without disturbing bearings.

10 TO 10,000 RPM—¼ TO 30 HP

Built-in gearing, protected from dust, dirt and drippings, is mounted within a pyramidal structure in the U. S. Syncrogear motor. Gears forever remain in proper alignment. The sealed oil reservoir provides perfect lubrication to all gears. Every casting is normalized, preventing inaccuracies of bearing settings. The motor windings are asbestos protected, to guard against carbonization. The centricast rotor is indestructible. Complete harmony in design insures strength without stress, extreme compactness and continuous quiet operation without over-heating.

U·S
SYNCROGEAR
MOTORS

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U.S. ELECTRICAL MOTORS Inc.

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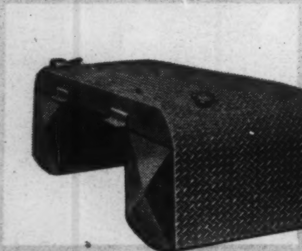
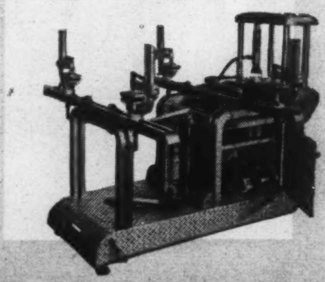
Sales and Service Offices In All Principal Cities

You're Always Safe and Safe ALL Ways On





AW SUPER-DIAMOND FLOOR PLATE
A BETTER FOOTING FOR PRODUCT AND PLANT

Grip Without A Slip!
Easy To Clean!
Easy To Match!

Install AW Super-Diamond Floor Plate in your plant and say goodbye to costly slipping accidents and floor maintenance bills. The exclusive engineered pattern provides maximum skid resistance regardless of how the plate is laid or the angle from which it is approached. More and more architects are specifying AW Super-Diamond Floor Plate, and leading Product Designers are using it for machine tool bases, saddle tanks and similar products on which men walk and climb. For safety's sake specify AW Super-Diamond Floor Plate for your plant and products. Write for more information and 16-page, fact-packed catalog.

AW SUPER-DIAMOND
FLOOR PLATES THAT GRIP

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A Product of ALAN WOOD STEEL COMPANY
CONSHOHOCKEN, PENNA.
OTHER PRODUCTS: Permaclad, Stainless Clad Steel • A W Algrip, Abrasive Floor Plate • Billets • Plates • Sheets (Alloy and Special Grades)

machining aluminum compare with those for machining cast-iron pistons, so the major price differential between the two types lies mainly in the higher cost of aluminum alloy

6. The engine assembly must be balanced within one-sixteenth of an ounce-inch to be satisfactory, which also creates production problems and requires development of new machinery. Present equipment is capable of balancing within one-eighth of an ounce-inch.

Such close weight limits on reciprocating parts are necessary to minimize the undesirable secondary unbalance condition at the higher speeds at which the future engine will operate. This unbalance cannot be corrected after the engine is assembled.

The project engineer can materially facilitate manufacturing if he will design the main bearings to tolerate a variation of 0.0015-in. in clearance without adverse effects. The production problems posed when it is necessary to maintain more limiting tolerances are not only complicated, but also costly.

Another factor is the design of the combustion chambers for production by casting or machining. A chamber cannot be cast within volume limits of less than ±0.1-cu in. on a production basis, due to inherent variations in casting which result from factors like warpage, sands, cupola mixes, and permeability of molds. Very likely a variation of 0.2- cu in. could be tolerated at compression ratios less than 8 to 1; it would be more economical to use cast chambers in this range.

Machined Chamber Will Be Needed

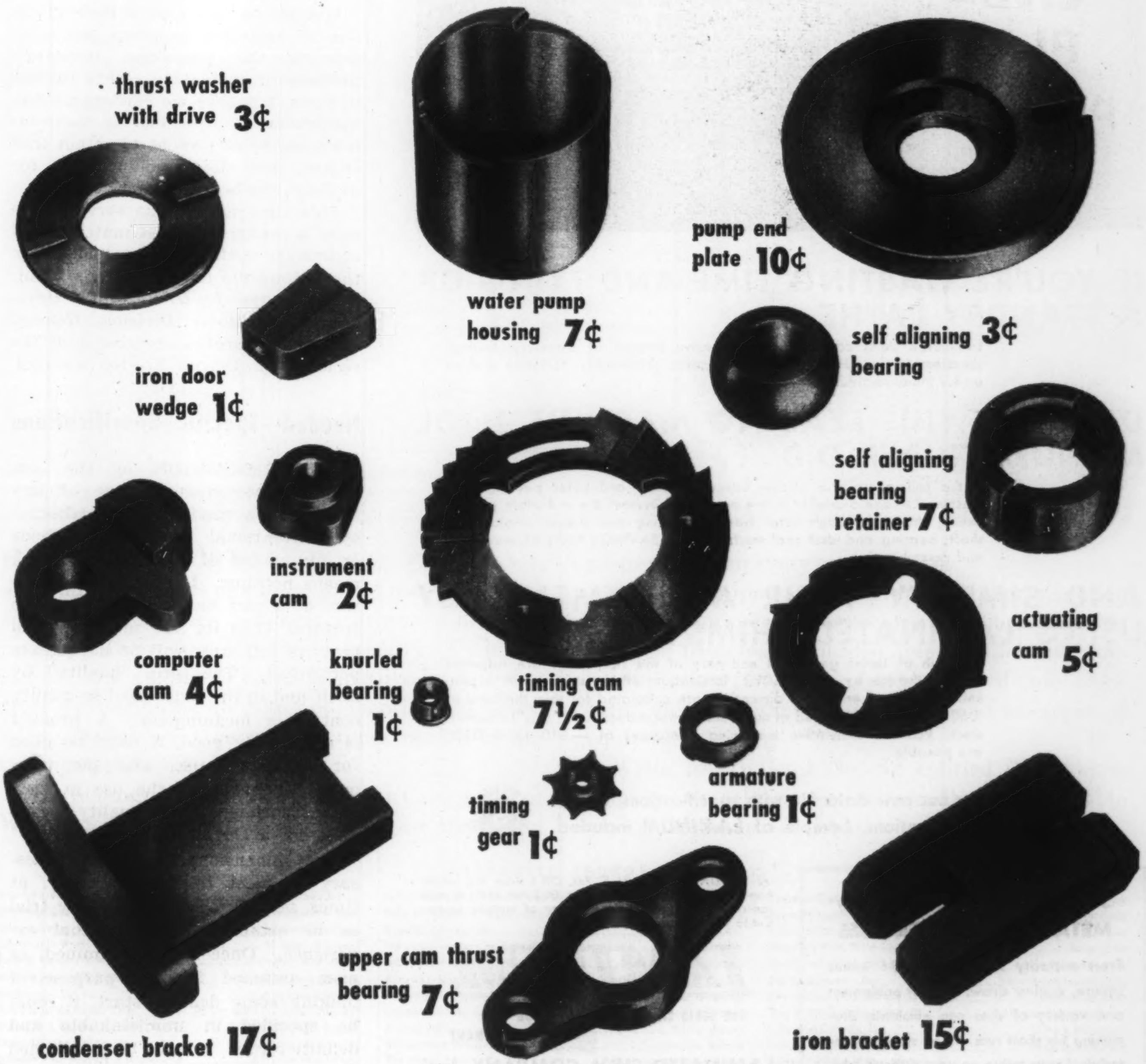
As ratios are increased, it will be necessary to hold variations to progressively smaller increments. At such time the machined chamber will be required. Machining will be more economical than trying to hold a cast chamber by grit blasting or other methods in production.

In most cases, changes in manufacturing methods will result in an abrupt departure from past procedures and will entail considerable equipment and tooling expenditures. If the present engine manufactured by the company—such as a valve-in-head V-8 or straight six—is adaptable to high compression, some of the existing equipment might be usable to manufacture the new engine. But in most cases the equipment will be obsolete.

This stems directly from development work on continuous or process type machinery. The advantages pro-

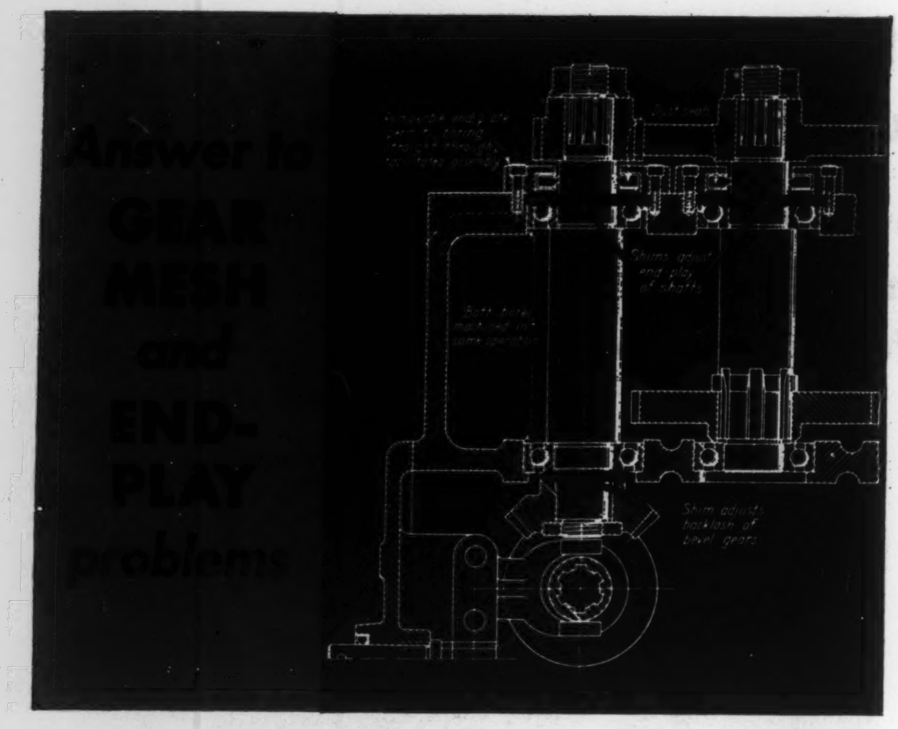
These GRAMIX parts of intricate design, in quantity production, cost only 1¢ to 17¢ each

die pressed of powdered iron or bronze to within .0005″
eliminate costly machining time
oil impregnated for self lubrication


thrust washer with drive 3¢
water pump housing 7¢
pump end plate 10¢
iron door wedge 1¢
self aligning bearing 3¢
self aligning bearing retainer 7¢
instrument cam 2¢
actuating cam 5¢
computer cam 4¢
knurled bearing 1¢
timing cam 7½¢
armature bearing 1¢
timing gear 1¢
upper cam thrust bearing 7¢
condenser bracket 17¢
iron bracket 15¢

GRAMIX

THE UNITED STATES GRAPHITE COMPANY • SAGINAW, MICHIGAN
DIVISION OF THE WICKES CORPORATION


Answer to
GEAR
MESH
and
END-
PLAY
problems
Removable end-plate permits boring straight through, facilitates assembly
Dust seals
Shims adjust end-play of shafts
Both bores machined in same operation
Shim adjusts backlash of bevel gears

IF YOU'RE WASTING TIME AND TYING UP A STANDBY LATHE . . .

Laminated shims can stop the expensive process of assembly, testing, disassembly, machining a few thousandths, reassembly, retesting and so on for many costly hours.

DO WHAT THIS LEADING MACHINE TOOL MANUFACTURER DID . . .

In the milling machine above, bores for inner and outer bearings are machined to one diameter in one operation. Removable end-plate permits boring straight through outer bearing housing and makes assembly of shaft, bearing and dust seal much simpler. SAVING: hours of machining and assembly time.

AND SIMPLIFY YOUR ADJUSTMENTS BY USING LAMINATED SHIMS . . .

Backlash of bevel gear and end-play of the two shafts are adjusted right at the job by peeling .002" laminations off the shims—with a penknife. Shaft and end-plate dimensions are calculated for shim thickness of .052". Shims are stamped at our plant from standard .062" (1/16") LAMINUM stock. RESULT: cumulative machining tolerances of —.010 to +.020" are possible.

Send today for our new data file with specifications, design factors and applications. Sample of *LAMINUM* included.

SEE OUR CATALOG IN SWEET'S FILE

STAMPING • GRINDING
METALWORKING SERVICES

Press capacity to 100 tons, 24 inches square, shallow draw. Special equipment and variety of dies can eliminate die-making for short runs. Wide stock of materials. Let us quote on your *difficult* jobs.

✻ *LAMINUM* (Reg. U. S. Pat. Off.) shims are solidly bonded units made up of .002 or .003 inch brass or steel laminations with a microscopic layer of metallic binder. Cut to your exact specifications.

LAMINUM
THE SOLID SHIM THAT *peels* FOR ADJUSTMENT

LAMINATED SHIM COMPANY, Inc.
1212 Union Street Glenbrook, Conn.

SHIMS SHIM STOCK STAMPINGS AN-COR-LOX NUTS

vided by this type of machining are exemplified mainly by reductions in labor costs and elimination of scrap due to inherent human errors. But when new equipment has to be acquired on a large scale, or where expense of reworking the old equipment is prohibitive, this new type of machinery satisfies most requirements.

Major disadvantage of this machinery rests in the fact that it lends itself to specialization and is not easily adaptable to design alterations once installed. This factor should be kept in mind when procuring equipment to avoid premature obsolescence.

Due to the high cost of such an extensive retooling program and considering the petroleum industry's problems in increasing octane ratings of fuels, I believe we can expect any manufacturer who has a valve-in-head engine at present to retain that engine, with slight modifications, for at least another year or two.

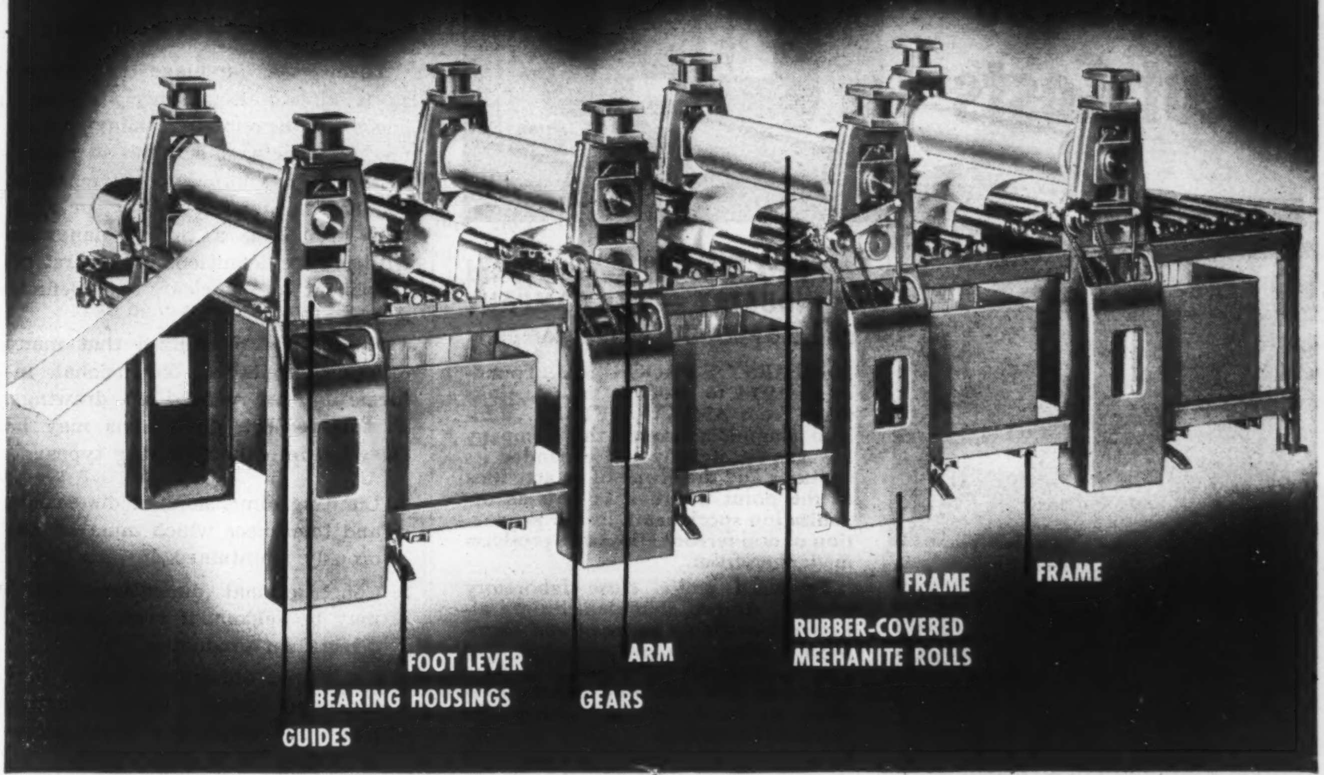
This time might also serve to realize a readjustment in material and equipment costs, which would act in the automobile manufacturer's favor. *From a paper by H. Richard O'Hara, Jr., Buick Motor Division, General Motors Corporation, presented at the recent SAE Detroit Section meeting.*

Needed—Specific Specifications

DETERMINATION of the size and variation in size of any feature of a product alone, whether by conventional inspection methods or by means of statistical control, means nothing. If that part or feature of a part has a definite duty to perform, then its size must be such that its full duty will be adequately performed. The term "quality" by itself and in the sense used in quality control is meaningless. A product is not simply good, it must be good for a certain use, and the term quality apart from the use in view means nothing. Good quality means good for a certain use.

The dimensional condition necessary to meet this quality may, at times, need to be determined by trial or be established from actual experience. Once it is determined, or even assumed for the purpose of making some definite start, it must be specified in unmistakable and definite terms. It must be so specified that anyone "skilled in the art" can, by means of definite measurement or comparison, demonstrate definitely that either it does meet the specifications or it does not meet them. There must be no foggy region of uncertainty. Whether or not the dimensional specifications are the

MEEHANITE® Properties make this machine BETTER, STURDIER, FASTER



H. W. BUTTERWORTH & SONS CO., Philadelphia, are leading builders of a large line of textile industry equipment. Castings for their machinery are produced in their own Meehanite foundry. Their designers and engineers build in quality by utilizing from the beginning the better engineering characteristics available in the various types of Meehanite castings produced.

The photograph shows a Butterworth Compartment Washer and also indicates the variety of Meehanite castings used in every compartment.

To the equipment they provide higher vibration absorption properties; better strength characteristics; freedom from fear of hidden defects which might result in failure; in all,—a combination of those characteristics so important to builders of all types of equipment.

Write for Bulletin No. 32 entitled "Meehanite Quality Control Assures Uniform Dependability" to any of the foundries listed.

MEEHANITE FOUNDRIES

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis-Fensom Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pehlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

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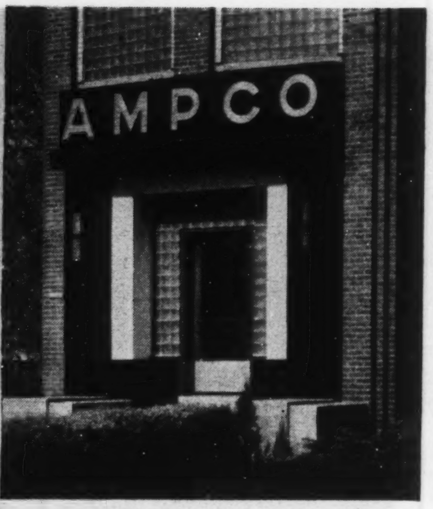
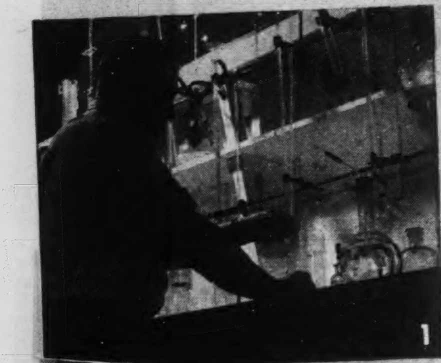
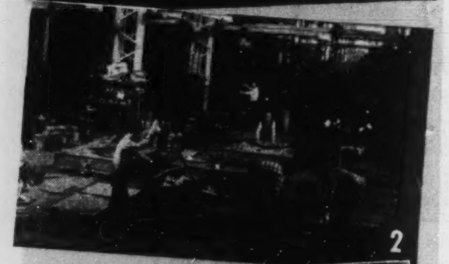
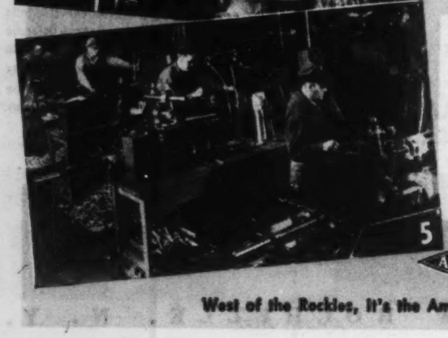
AMPCO Versatility helps you Cut Costs









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35 YEARS OF PROGRESS... Founded in 1914 to produce sand castings made from AMPCO METAL... a hi-iron aluminum bronze, the Company has grown steadily and expanded its facilities and the scope of its activities to the point where it is now an organization specializing in the production of non-ferrous alloys and products made therefrom.

Produced under close laboratory control, Ampco aluminum bronze alloys are available as: *sand and centrifugal castings; extruded rod, tube and simple shapes; rolled sheet and plate; forgings; arc and resistance welding electrodes; machined parts; valves; pumps and fabricated assemblies.*

In addition to aluminum bronzes (still the major product) Ampco Metal produces, under the same laboratory control, many other copper-base alloys including: phosphor bronzes; tin bronzes; nickel bronzes; manganese bronzes and Ampco Beryllium-copper.

Ask an Ampco Field Engineer for further details... make full use of our engineering service.

1. **Laboratory Control and Research.**
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AMPCO METAL, INC.
MILWAUKEE 4, WISCONSIN

West of the Rockies, it's the Ampco West Coast Plant, Burbank, Calif.

correct ones, there must be no uncertainty about the actual dimensional conditions that are specified. If these specifications themselves are incorrect, they can be corrected. If the method or language used to specify them is ambiguous and indefinite, then no correction is possible until the language has been perfected.

Present Language Incomplete

The present language of drawings as it affects dimensions and tolerances is incomplete, ambiguous in many respects, and dumb in regard to many very important dimensional conditions. Whether words or symbols are used, a precise language with precise definitions is the first requirement of a clear and definite specification.

It must be recognized that many different kinds of dimensional information are needed on drawings. In this respect, dimensions may be classified into the following types:

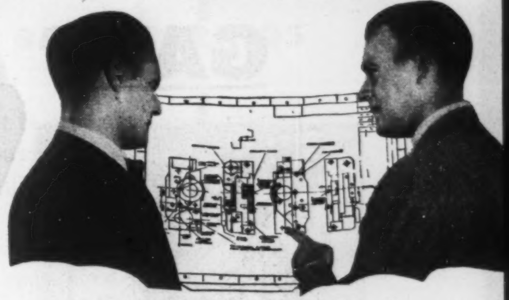
1. Limiting dimensions or dimensions and tolerances which must be rigorously maintained.
2. Constructional dimensions which may be seldom, if ever, measured directly in production.
3. Calculated dimensions which may represent some basic starting point but which are never measured directly in production.

Some notation should be adopted to identify these different types of dimensions. The limiting dimensions themselves serve different purposes and must be considered under different categories. Effective methods for their control require different treatments. But first of all, it is necessary to reach a definite agreement as to the fundamental meaning of the limiting dimensions on the drawing. For this, in the writer's opinion after over forty years' contact with this problem, the only logical and defensible interpretation is that the limiting dimensions, on the part drawing, represent the requirements of the inspection gages. In other words, it must be possible to translate every limiting dimension into a definite form of measurement or definite design and size of an inspection gage. Hence these dimensions specify specific tests with specific gages and all parts of the product that meet these tests must be adequate dimensionally to meet the service or use requirement. This is no easy task.

Limiting dimensions are required

Created for the 28,000 users of direct process and blueprint machines

The first low-cost photographic intermediate paper . . . a revolutionary new product that gives you, for the first time, positive photographic intermediates directly from your tracings . . . *without a negative step.* Furthermore, Kodagraph Autopositive Paper can be exposed in your direct process or blueprint machine . . . and the prints processed in standard photographic solutions—everything done under normal lighting . . . right in the drafting room, if you wish.



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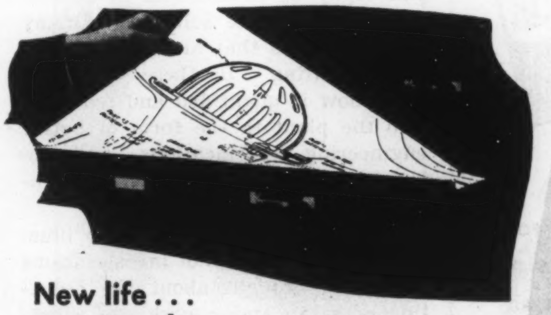

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3 NEW

GAST AIR PUMPS

GAST ROTARY DESIGN GIVES *BOTH* VACUUM *AND* PRESSURE FOR FEEDING APPLICATIONS

Model 3040, new SINGLE CHAMBER PUMP—19 to 24 c.f.m. Pressure up to 10 p.s.i.—vacuum 15" and over.

Model 10 x 1040, small DUAL CHAMBER PUMP—9 c.f.m. from each chamber. Vacuum to 20", pressure to 15 p.s.i.

Model 11 x 1740, large DUAL CHAMBER PUMP—14 c.f.m. (to 10 p.s.i.) from pressure chamber; 9 c.f.m. (to 15") from vacuum chamber.

Look what these 3 new Air Pumps offer: They're designed to meet the specific needs of automatic feeding operations . . . handling paper, cardboard, thin metal, acetate, etc. They give *both* strong "blow" for separating—and large capacity low vacuum for "pick-up" of sheet materials.

With all the inherent advantages of Gast Rotary Design, they run quietly, producing large volume per horsepower at comparatively low speeds. They're trim in appearance and unusually compact. V-belt drives simplify installation and make speed control easy.

If you're building machines that can be fed with suction fingers—you'll want full details. Remember —"Air may be *your* Answer!"

WRITE FOR DETAILS ON 3 NEW AIR PUMPS—ALSO "APPLICATION IDEAS" BOOK

see our CATALOG in SWEET'S FILE

GAST ROTARY

AIR MOTORS • COMPRESSORS • VACUUM PUMPS
(TO ONE H.P.) (TO 30 LBS.) (TO 28 INCHES)
GAST MANUFACTURING CORP., 107 Hinkley St., Benton Harbor, Mich.

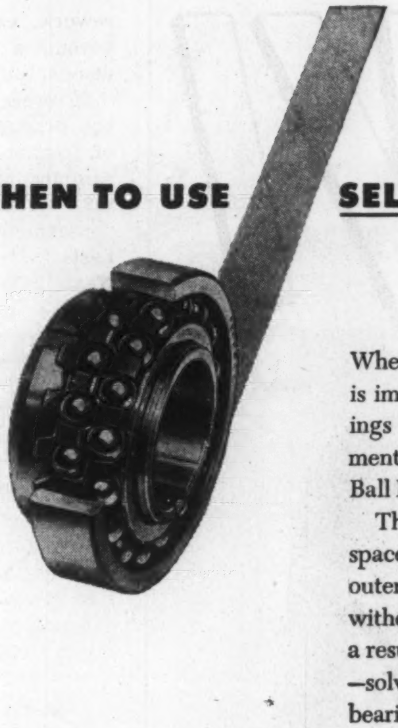
to specify the following conditions: (a) Conditions of size; (b) conditions of form; (c) conditions of operation or functioning. The method of specifying the permissible variation or tolerance must be different on each of these conditions. Conditions of form or conditions of position treated in the same manner as conditions of size lead to chaos. Gages of size, gages of form, gages of position, and functional gages all have quite different characteristics. The present practice takes care of but little more than conditions of size, with a slight approach to conditions of form. Conditions of position have been ignored almost completely. We need a vocabulary and dictionary which will cover all of the different dimensional conditions. *From a paper by Earle Buckingham, professor of mechanical engineering, Massachusetts Institute of Technology, presented at third annual convention of American Society for Quality Control.*

Trouble Shooting with Quality Control

STATISTICAL quality control in a job shop producing upward of a thousand different products for equally as many customers, might well be impossible were the common usages applied. The problems of introducing and using control charts, frequency distributions, and sampling tables into the score of mechanical manufacturing, processing and assembly operations of a conservative New England plant with three generations of "know-how" can be readily imagined. However, Dr. Shewhart's philosophy of control can be and is put to use in the solution of many daily problems that arise in contract manufacturing. In these cases the know-how is quantified and fed back into the plant in the form of better engineering specifications, and relayed to the customer for more complete service.

Actual cases will be used to illustrate the end results of investigations that have brought about the reduction of scrap and rework, the elimination of 100 per cent inspection, and the forecasting of machine tolerances and tool wear.

The first product investigated statistically in the plant was a throttle rod linkage in a recently retooled popular priced car. The company had produced similar rods for about twenty years without too much difficulty and a minimum of written specifications, but when this product went into production, thirty to forty per cent of the assemblies were found to be defective. Seven departments contributed to this scrap and



WHEN TO USE SELF-ALIGNING DOUBLE ROW RADIAL BALL BEARINGS

Wherever shafts bend or deflect beyond the norm—where it is impossible to machine the housings in line, or when housings are mounted on separate structures and perfect alignment is impossible—Federal Self-Aligning Double Row Radial Ball Bearings meet the need for correcting such misalignment.

These versatile bearings are engineered so that the balls, spacer and inner ring always rotate *freely* within the spherical outer race at a considerable angle on either side of normal without binding or additional strain on the bearing parts. As a result, they are *quiet-running*, smooth-aligning and durable—solve problems which cannot be handled by ordinary radial bearings.

Federal Self-Aligning Double Row Radial Ball Bearings are made in light, extra-light, medium and heavy series; in regular and wide types for any load requirement; and in adapter and wide inner ring types for securing at any point along a plain or shoulderless shaft.

They're all described in our catalog "K," which covers the complete Federal line...every type and size, shielded and sealed...for every anti-friction need. (A few of the many types are shown here.) You'll also find ball bearing selection charts to help you compute bearing loads, determine capacities at every speed, and select the type and size ball bearing best suited to your application. Write today for your copy of this 260-page catalog.

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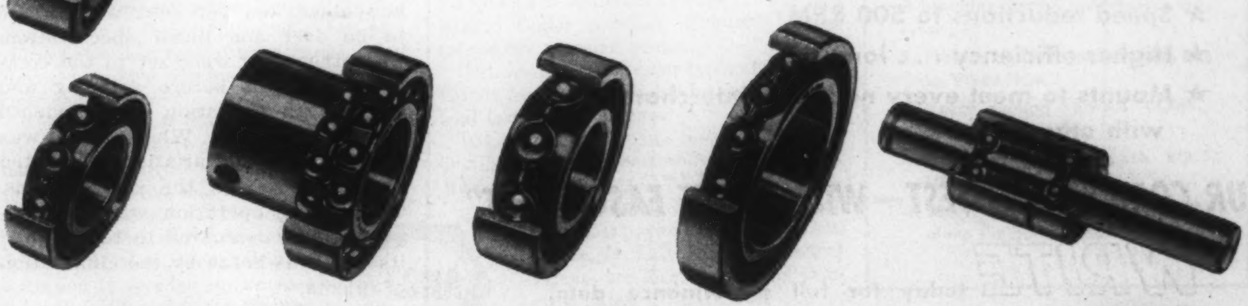

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ONE OF AMERICA'S LEADING BALL BEARING MANUFACTURERS

Quality since 1908

FASCO 6-POLE SHADED POLE MOTORS, 1/30 THRU 1/8 HP, 1000 RPM

- ★ Quiet . . . uniform performance at ALL speeds
- ★ Speed reductions to 500 RPM
- ★ Higher efficiency . . . long life
- ★ Mounts to meet every need . . . interchangeable with other motors

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FASCO
INDUSTRIES, INC.

rework, each of which was certain beyond a doubt that the other six were totally at fault.

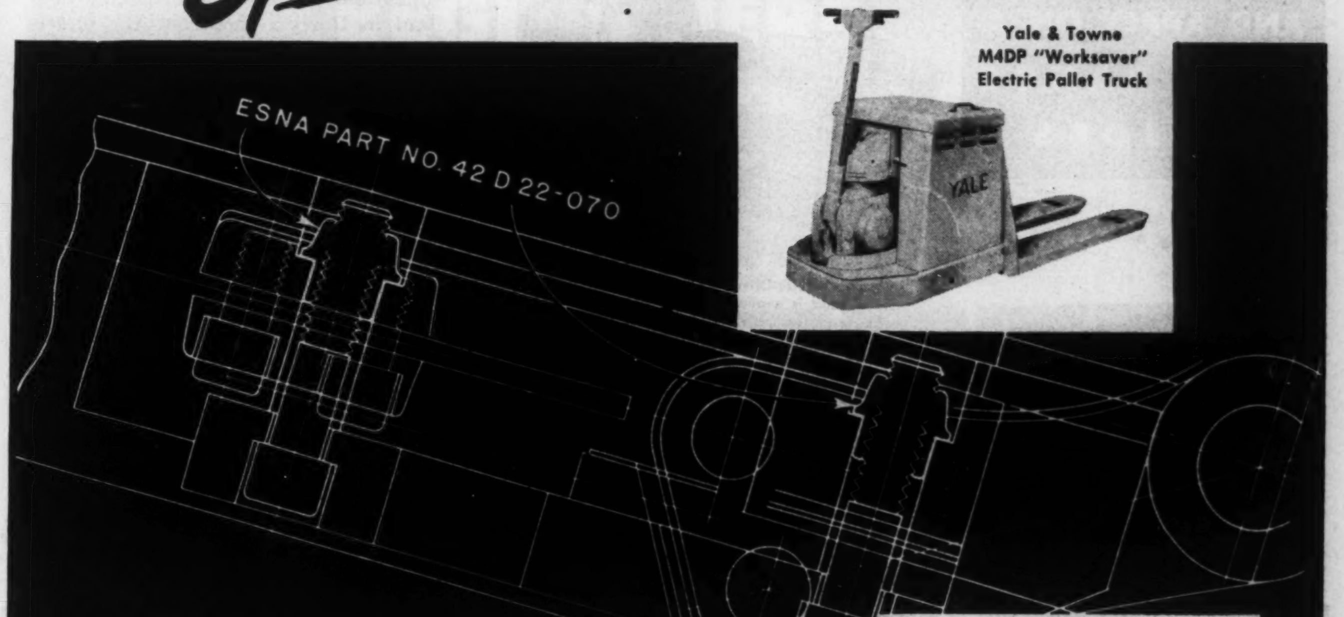
In order to investigate the causes, the product was analyzed by means of frequency distributions of random samples at each stage of manufacture. Thus the quality level of each department was evaluated and a basis for remedial action established. Next, a lot was put through normal routine using control chart techniques to check the process capabilities with the print tolerances and to ascertain whether a state of control existed. This information was accumulated and issued to the plant in the form of new specifications, considering the product as a whole, and soon after the product was produced at one-half of one per cent defective. The results have been applied to similar products and have provided an entering wedge for statistical thinking in the plant.

Sorting Operation Eliminated

The second case illustrates how an expensive 100 per cent sorting operation was eliminated by a study of the processes and a shift in their order. In the manufacture of compression springs, the least accurate stage of the process is the first operation; that of the spring coiler. To reduce variations in length or load, it is necessary to grind, set and test springs in that order. The set and test operation is a combined one and precedent had established it as the least expensive method. However, in the face of competitive bidding it was necessary to reduce the cost by the amount of the inspection operation and the quantity rejected. To quickly test whether this was possible, a coiler was set up to produce the maximum variation in length and load for a hundred samples. Fifty were processed through the time-tested way and about ten per cent were found to be over and under specification. The other fifty were set to the compressed height before grinding and the length variation was reduced about 25 per cent. When this lot was ground, the load variation distributed itself well within the specifications. The setting operation was an inexpensive one compared to testing and its cost was borne by the elimination of rejects.

The last case was a simple screw machine brass bushing with tolerances to spare. A test was running to determine the weight per thousand pieces when it was found that the length varied only 20 per cent of the tolerance and always on the high side. Because it was a small piece the total tolerance mounted to about 10 per cent of the material. Needless

Self Locking Spline Nuts FOR COST-CUTTING PRE-ASSEMBLY METHODS



Yale & Towne
M4DP "Worksaver"
Electric Pallet Truck

—The Red Elastic Collar protects inaccessible bolted fastenings from failures due to VIBRATION!

After testing many types of fastenings Yale & Towne selected ESNA spline nuts as the solution for the blind mountings on the front and rear assemblies of the M4DP "Worksaver" Electric Pallet Truck featured in this ad. Loose bolts at these inaccessible locations meant loss of adjustment and mechanical wear. Their research proved that self-locking connections at these application points provided protection against unnecessary down time . . . added assurance against service calls and repairs.

This is a typical example of the growing industrial acceptance gained by ESNA spline nuts . . . especially designed for easy driving into soft gray iron, magnesium or aluminum castings. By means of this simple installation the casting is given a threaded member; a tough drilling operation is speeded up because the drill is allowed to run through the casting . . . costly tapping operations are eliminated. The self-locking collar does away with expensive cap screw lock wiring and fully protects inaccessible or blind mountings from operating failures.

In addition, if dis-assembly is required, ESNA spline nuts remain securely positioned for quick reinstallation and the famous Red Elastic Collar provides adequate locking torque for repeated re-use.

This is only one of many types of standard Elastic Stop Nuts available for special industrial fastening problems.

HERE'S A CHALLENGE: Send us complete details of your toughest bolted trouble spot. We'll supply test nuts—FREE, in experimental quantities. Write: Elastic Stop Nut Corporation of America, Union, N. J. Representatives and Agents are located in many principal cities.

ESNA
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THE FAMOUS RED ELASTIC COLLAR IS VISIBLE EVIDENCE OF LOCKING SECURITY

Threadless and permanently elastic, it provides these 4 outstanding features:

1. Protects against nuts loosening due to VIBRATION
2. Keeps locking threads CORROSION FREE
3. Provides for accurate BOLT LOADING
4. Seals against LIQUID LEAKAGE along the bolt threads

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COMPACT

Series "K" Roper Pumps

EASY TO INSTALL AND APPLY ON A WIDE RANGE OF JOBS

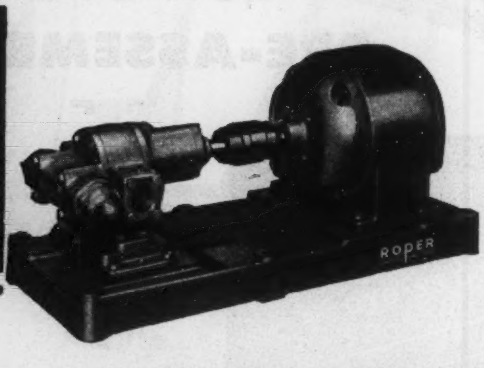

Fig.26K Motor-Driven Pump Unit with built-in relief valve head is available in all sizes. Also Fig. 25K with head less relief valve. Includes bedplate and coupling to suit standard motor frames. Furnished with or without motor.

Fig. 1K Pump Head with packed box, built in 5, 10, 15, 20, 30, 40, and 50 g.p.m. sizes. Fig. 2K has built-in relief valve. Mechanical seal available on all models.

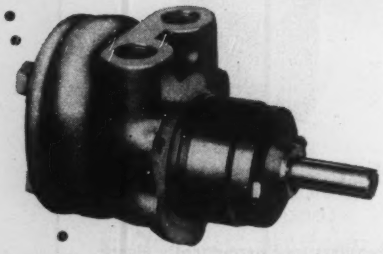

Fig. 17K Pump Head with mechanical seal. Capacities ¾, 1½, and 3 g.p.m. sizes. Packed box is available. Fig. 18 K is equipped with built-in relief valve.

Yes, you can save space and reduce power costs with Roper Series "K" Pumps. They are very compact in design, yet sturdy enough to handle a wide range of jobs . . . pressure lubrication, hydraulic service, fuel supply, or transfer work pumping clean liquids at capacities up to 50 g.p.m.

They are self-lubricated by the liquid pumped . . . handle total suction lifts up to 25 feet . . . come equipped with mechanical seal or packed box . . . with or without relief valve.

Venturi suction and discharge principle provides properly proportioned distribution of liquid pumped, thereby minimizing energy loss through turbulence, cavitation, or friction.

Series "K" pumps are available in ¾ to 50 g.p.m. sizes, pressures to 150 p.s.i.

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Rotary Pumps

to state, the limits were changed to the low side with a resultant saving in raw material. The reason given for the large tolerances was the high speed of production, which made for high tool wear. It was found that this was caused by incorrect setting and the need for machine tending was reduced.

There are many other specific applications of statistical quality control in the job shop, but the underlying motive for these investigations is the quantification of the existing know-how and the successful forecasting of new techniques. *From a paper by E. E. Schiesel, Stevens Institute of Technology, presented at third annual convention of American Society for Quality Control.*

How To Boost Quality

WE are emerging from a national quality spree. Since 1941, though plagued with materials shortages, labor shortages and equipment shortages, we have done a superb production job. But attached to much of that production was the visible tag of high price and the invisible label of poor quality.

Our shortages are now behind us, but the habits they generated are still with us. We relaxed standards, used ersatz materials and put up with subnormal machine maintenance. We handled vendors with kid gloves while kicking our inspectors and customers all over the place. We sanctioned the doing of these things, year after year. To sanction them we authorized changes in specifications, practices, routines. For the most part these changes are still on the books. For the most part these practices are still the prevailing practice. For the most part the habits of personnel are still those of low quality and high cost.

From my observation, there are three general methods being tried by executives to get back to high quality and low cost. Two of these methods are weak extremes. At one extreme is an eloquent appeal to personnel, pointing out that competition is here, that costs must come down, that quality must go up. This appeal, however eloquent, is bound to fail because it is not founded on a planned program for action. At the other extreme is a bits-and-pieces effort of getting after really bad instances as they rear their ugly heads. This effort is likewise doomed to failure because it just pecks away at the problem instead of going after basic causes with an organized plan of action.

The third and successful method is to prepare a comprehensive set of

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● One of the best known manufacturers of air circuit breakers in the country is the I-T-E Circuit Breaker Company, located at 19th and Hamilton Streets in Philadelphia. From its inception the company has displayed unusual receptiveness to new ideas, whether from within or without; hence it has done its share of pioneering, and perhaps more. Revere is proud to play a part in its progress, through close collaboration with I-T-E engineers, production men, and the purchasing department. The extensive use of Revere Extruded Shapes is but one result of our mutual attack upon I-T-E problems, which the company is good enough to say has saved a great deal of money, as well as made possible a better product . . . Perhaps similar results would be obtained if you gave us the opportunity to place our knowledge as well as our metals at your disposal. Why not inquire?

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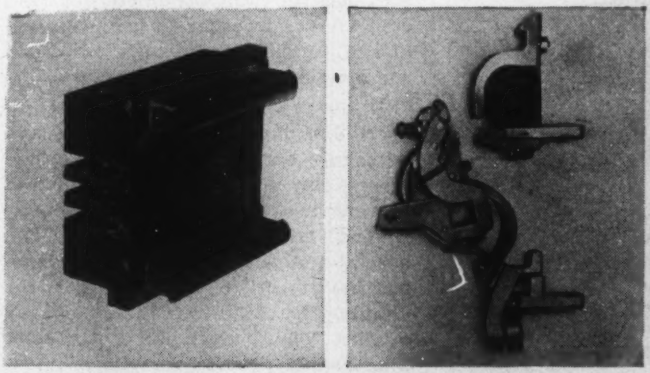
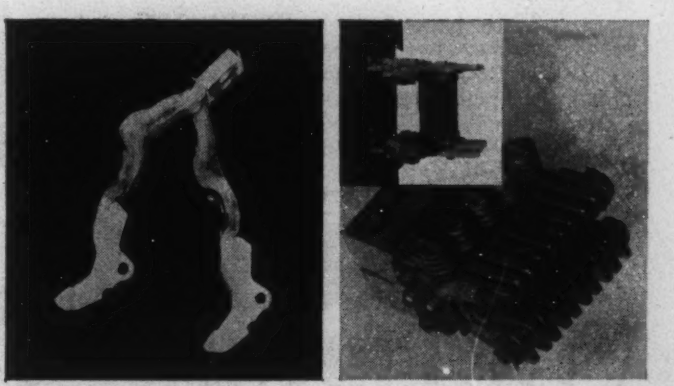
This is but a part of the I-T-E Stock of Revere Extruded Shapes in copper, brass, manganese bronze, and aluminum. I-T-E is a great advocate of extruded shapes, from long experience finding them markedly superior, in uniformity, strength, and economy due to the fact that a great deal of machining is avoided.



(*Left*) I-T-E Contact Block made from an extruded shape. This was formerly extruded in electrolytic copper; changing to Revere Free-Cutting Copper resulted in a saving of 30% in machining time. (*Right*) I-T-E "K" Breaker, Main Contact Assembly in open position. This is an especially interesting assembly, since it shows no less than eight extruded shapes in copper and bronze. Use of these shapes makes the assembly more compact, stronger, lighter, and considerably more economical to produce. The contacts are silver alloy, and the unit is silver plated. . . . In addition to supplying I-T-E with extruded shapes, and strip, Revere furnishes rolls, bar, rod, sheets, in a wide range of non-ferrous alloys, and seamless brass tube.



(*Left*) Main movable Contacts and Flexible Connectors in an I-T-E "K" Type Circuit Breaker. The two contacts are made from Revere Extruded Shapes. Revere and I-T-E collaborated closely on the specifications for the thin-gauge copper strip for the pigtails, working out the correct gauge and temper to avoid notch effects and cracking of the connection at the braze. (*Right*) Main Separable Contacts from an I-T-E Type "LG" Circuit Breaker. These are stamped from Revere Copper Strip with the temper specially controlled to eliminate a de-burring operation previously found necessary to obtain edge surface suitable for electrical contacts. (*Inset*) Back view of "K" type Breaker showing a similar type of contact.

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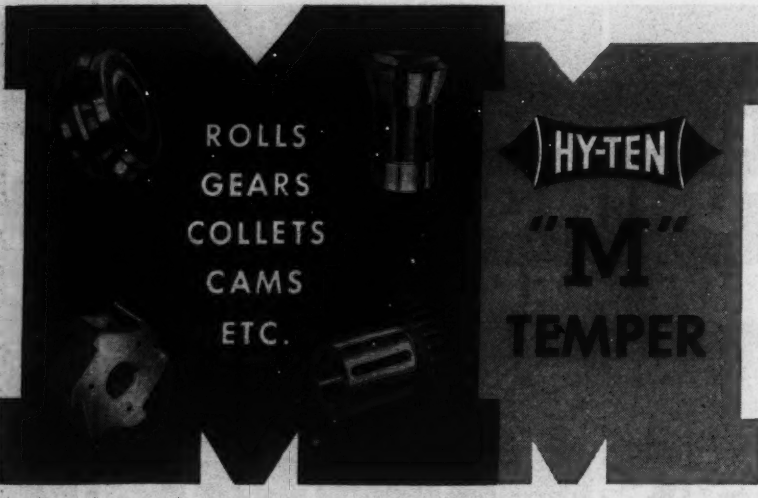

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objectives, to assign to everyone in the company a part he can play, to provide a scoreboard to measure the progress of the plan, and to supply the necessary stimuli for achieving the objectives. The essential elements of such a plan are as follows:

1. *Prove to each employee that he has a personal stake in the company's quality reputation.* This can be done by an internal advertising campaign—posters, slogan contests, reports from customers, articles in the house organs, moving pictures, anything appropriate for showing a clear connection between employees' personal interests and the quality of the final product.

2. *Compute the "gold in the mine" to demonstrate that better quality costs less.* Find out what the cost is which arises from presence of defects—the scrap, reworks, extra operations, discounts on seconds, service charges on guarantees, cost of sorting product when sampling might do, and so on. As often as not, half of this cost can be eliminated by a thorough program of modern prevention. Reduction in cost can finance the entire program of quality improvements with room to spare. The potential improvement is an index of how big a program to launch.

3. *Show each employee how he can personally contribute to better quality.* This means clear specifications of what is wanted. It requires clear instructions on how to run the processes. It requires adequate measurement or standards so that the employee can judge as he works whether he is doing the job right. Proper induction of new employees, good training, balanced incentive plans and good maintenance practice are part of this. Competitions and contests are in order to urge the employee to find new ways amid old surroundings to improve quality.

4. *Set up a quality control engineering group.* Shop supervisors and personnel can make many improvements. But many of the fundamental improvements require extensive fact-finding, trials and experiments, and special analysis of data. Shop personnel have neither the time nor the training to take on these lengthy studies. The budget for the master plan should provide for one or more quality control engineers.

5. *Provide for co-ordination and skilled counsel.* A program like the foregoing demands participation by all major departments—design, production, quality, sales, sales service, purchasing, methods, and others. Achievement of high quality at low cost is a teamwork job. A quality committee, with representation from

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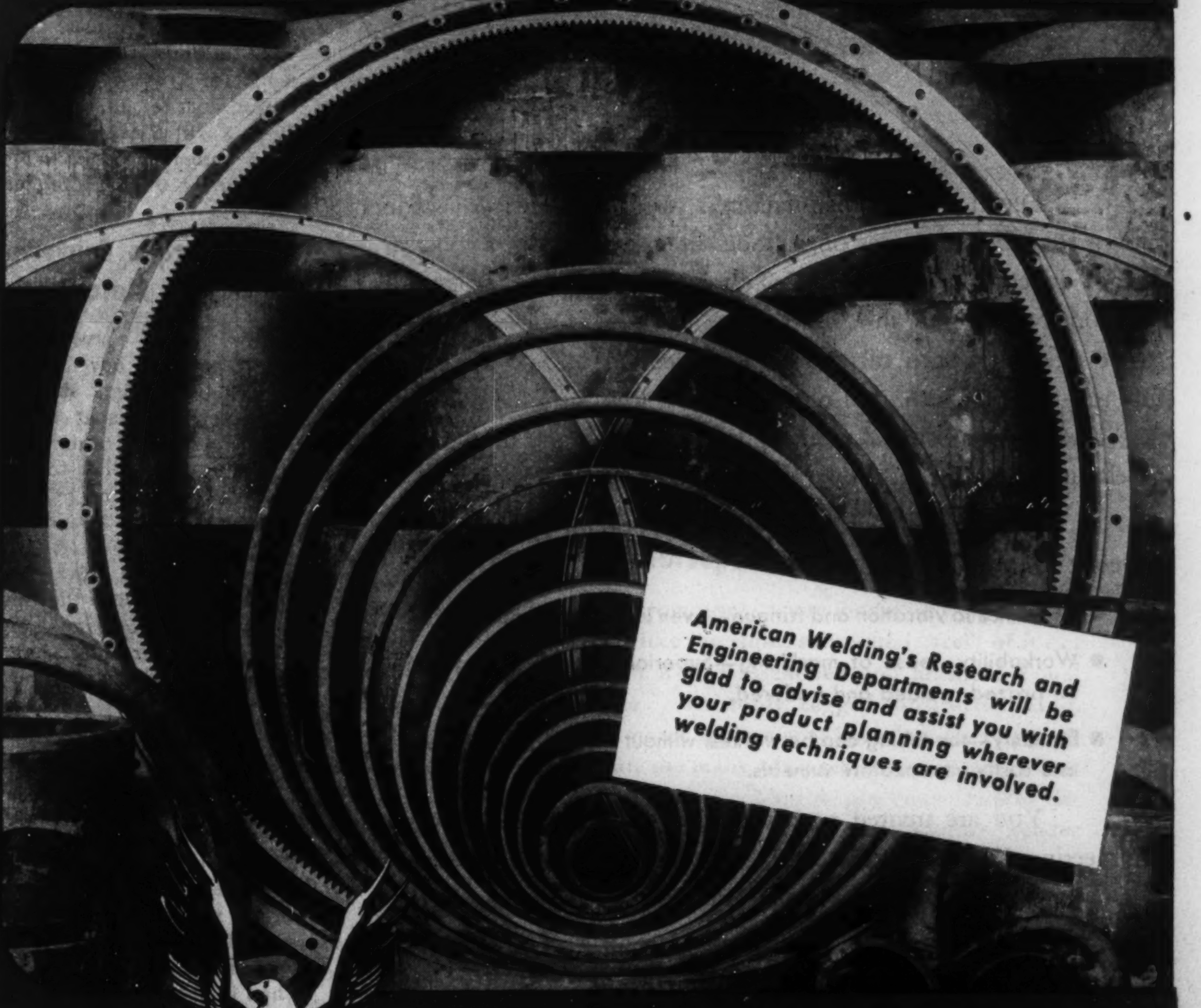

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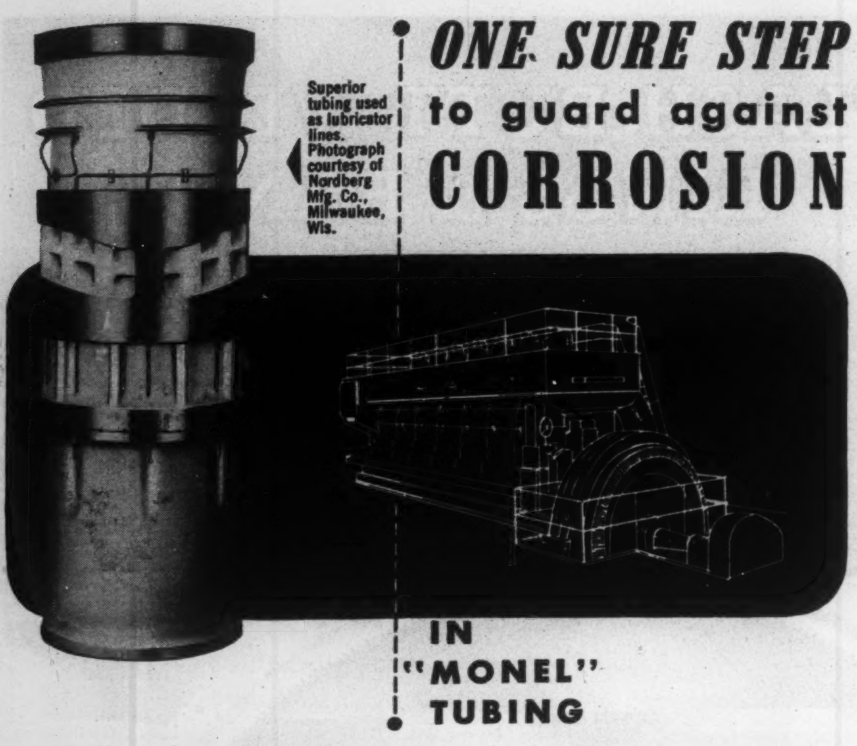

Superior tubing used as lubricator lines. Photograph courtesy of Nordberg Mfg. Co., Milwaukee, Wis.

Diesel engine manufacturers who use *Superior* "Monel" tubing for lubricator lines on cylinder liners, are taking a long stride toward dependable performance. Lubricator lines are small and vital; positioned as they are in a water jacket, they must withstand the corrosive effects of both oil and water. Selection of *Superior* "Monel" tubing—with its clean, non-pitting surface, its controlled ductility for ease of fabrication, its assured high strength—is one important way to eliminate tubing failure.

Consider—in addition—these important characteristics of Superior "Monel" tubing:

- **Resistance to vibration and fatigue—even in varying temperatures.**
- **Workability—ease of machining—Superior "Monel" tubing can be brazed, welded and soldered.**
- **Economy—the tubing can be worked without resorting to frequent and costly intermediate anneals.**

You are invited to make full use of the Laboratory and Engineering Department facilities at Superior and take the one sure step toward satisfactory tubing performance.

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the principal departments, is an admirable coördinating device. Where the company has never before embarked on such a program it is well to secure advice from companies who have gone through such a program. An alternative is to engage, as an adviser, some qualified consultant in the field.

Clearly, top management has not the time nor the specialized skill to understand and follow such a program in detail. The detail must be left to those who do have the time and the specialized skills. But top management must: (a) Understand the need for doing it at all; (b) realize the size and character of the job to be done; (c) provide the budget, organization, personnel and stimuli needed; (d) arrange for co-ordination of the broad program; (e) set up to measure results; and (f) regulate the program based on results achieved. *From a paper by Dr. J. M. Juran, dept. of administrative engrg., New York University, presented at third annual convention of American Society for Quality Control.*

Torque Converters Require Matched Engines

THE torque converter has opened up possible developments for future engine design, since engine and converter now must be matched to supplement each other.

The low-speed, low-torque, and low-efficiency parts of engine performance curves are made unusable by the converter. For this reason the engine designer now may concentrate on improving the upper ranges of engine performance without having to concern himself with the sometimes conflicting low-speed requirements.

Various means suggest themselves, including mechanically-driven or exhaust-driven superchargers. A mechanical supercharger drive making use of the speed differential across the converter seems possible by using a differential drive. This type of drive would provide engine supercharging in accordance with the vehicle's own torque demand rather than in accordance with engine speed.

With the advent of new prime mover types, such as the gas turbine, the hydraulic torque converter will continue to attract interest as a possible means of supplementing the characteristics of these new powerplants to provide a consolidated unit for automotive vehicle propulsion. *From a paper by Carl A. Lindblom, White Motor Co., presented at recent SAE Washington Section meeting.*

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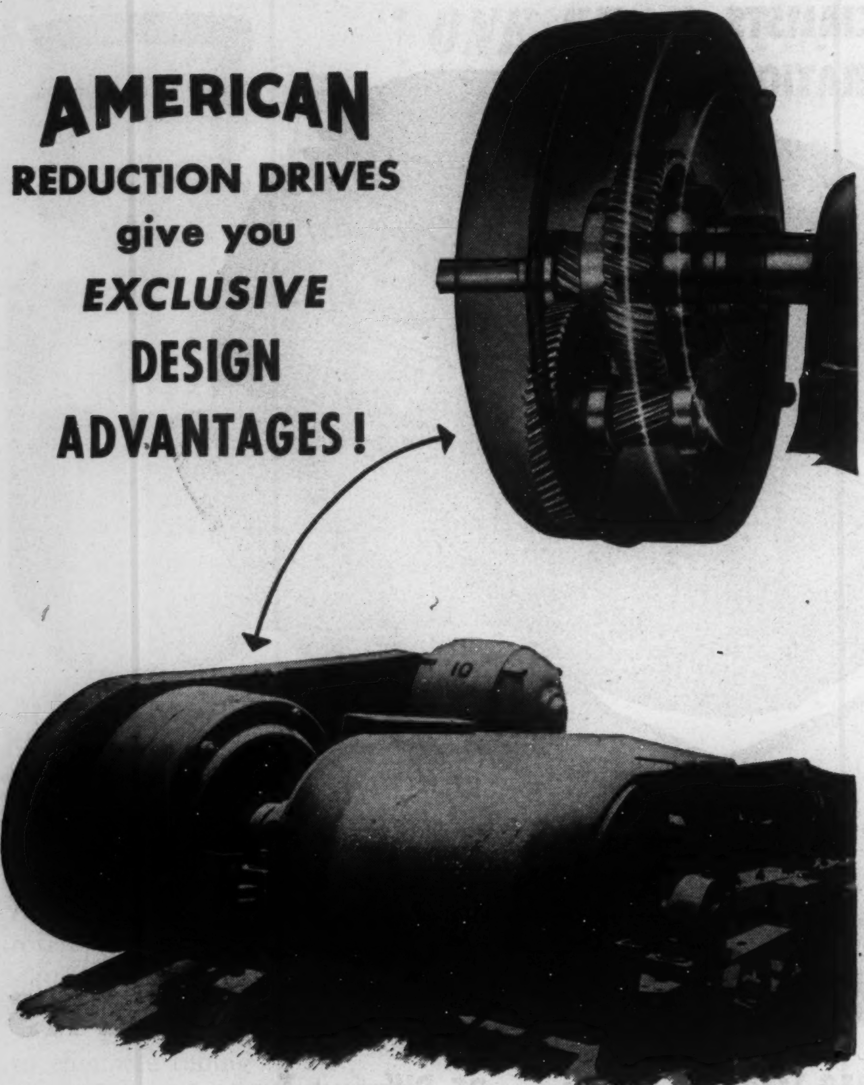

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REFRIGERATOR. New line includes 8 and 10-cu ft combination refrigerator-freezers and 8-cu ft medium-price refrigerator. Freezers have aluminum shelves, plastic food baskets and 3 ice trays. Refrigerator features stainless steel shelves, butter conditioner and storage space for 24 lb of frozen foods. Hotpoint Inc., Chicago, Ill.

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SHOVEL-FRONT TRACTOR ACCESSORY. Capacity, ½ cu yd. For track type tractors, unit may be mounted on either new or used machines without major alteration. Well adapted for grading, gravel pit excavation, general loading, etc. Hyster Co., Portland, Oreg.

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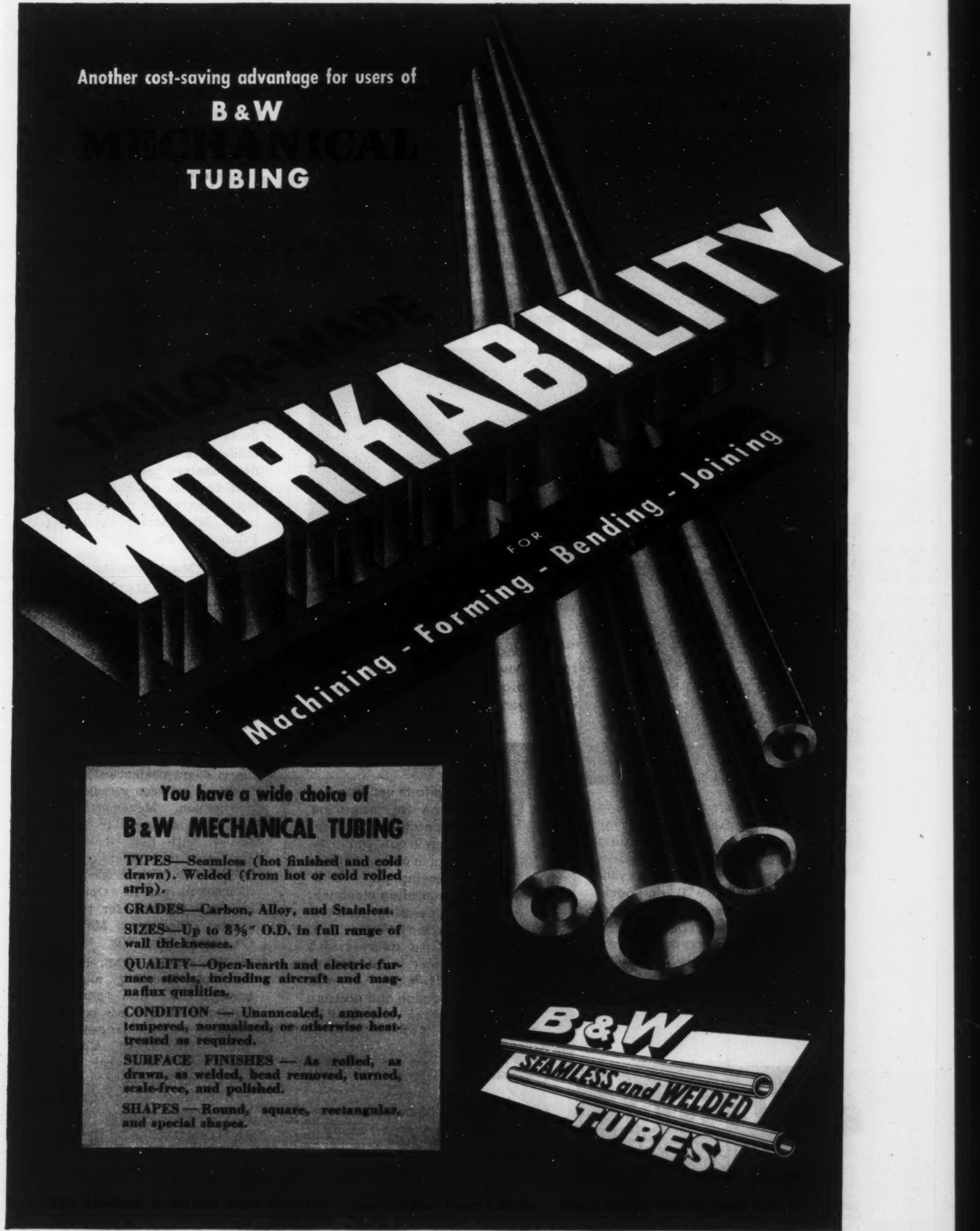

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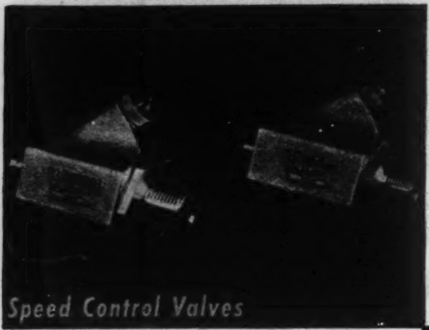

Pictured here are but a few of the many hydraulic devices produced by Electrol for industry . . . transportation . . . and agriculture. We will gladly supply further details as to the application of these units in the machines you use or the products you make. Or — better still—have our engineers work with you in adapting them to any specific design.

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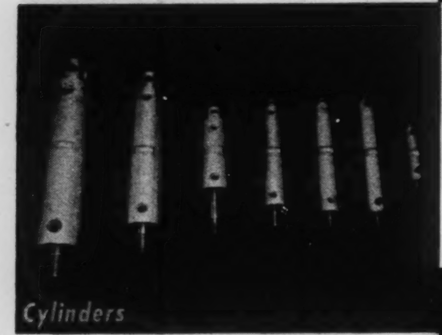

"500-1 Series" hydraulic cylinders available in bore diameters ranging from ¾" up to and including 3". Chromium plated piston rods, honed seamless steel tubing cylinders. Conventional "0" ring packings. Clevis mounting and standard pipe ports. Can be used in air or oil. Pressures up to 1,500 p. s. i.

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PORTABLE VENTILATORS. Equipped with high-velocity fans powered by gas engines or electricity. Air conveyed to desired point through 14-in. diameter, 16-ft long, collapsible ducts. Ducts treated for flame and mildew resistance. Two-way air flow feature permits connecting duct to inlet or discharge side of fan. Max of 32 ft of duct can be used. Mine Safety Appliances Co., Pittsburgh, Pa.

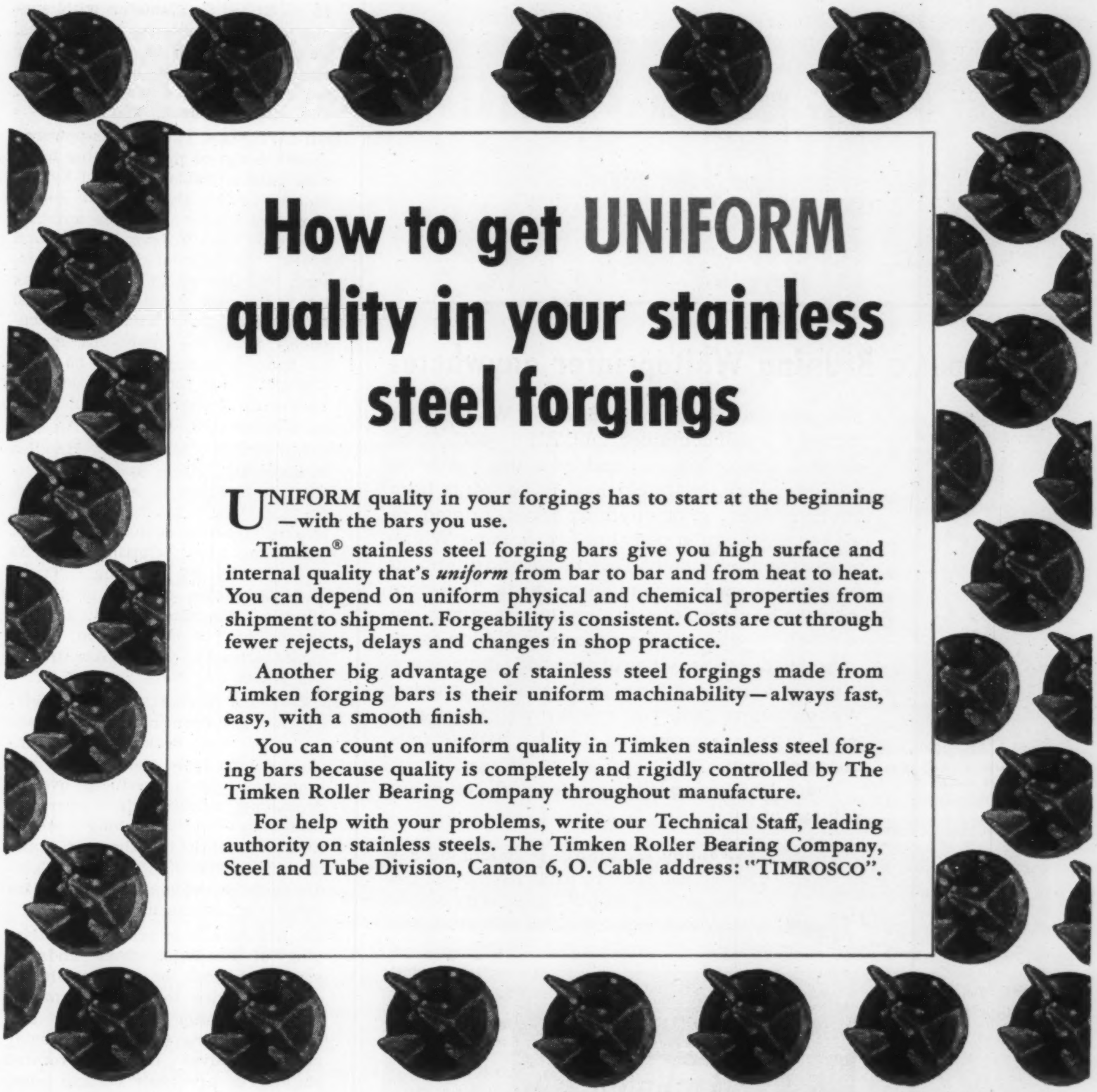
Manufacturing

LAYOUT DRILLING MACHINE. For work requiring more accuracy than is possible with standard drill but not precision of jig borer. Handles drilling, boring, tapping, reaming, milling and similar operations. Equipped with combination boring and drilling spindle with No. 4 Morse taper. Sliding head has friction type feed clutch with automatic, adjustable, depth kickout; spindle is counterbalanced to eliminate backlash between spindle feed rack and pinion. Movement of saddle and table accurate to 0.001-in. in 24 in. with 6-in. diameter dials graduated to 0.001-in. and verniers to 0.0001-in. Work tolerances held to 0.001-in. per ft. Optional power rapid traverse for table movements. Cleereman Machine Tool Co., Green Bay, Wis.

PIPE FLANGE MACHINE. For boring, reaming, threading and counterboring cast iron pipe flanges. Equipped with 3-jaw scroll chuck, machine handles flanges from 3 to 16-in. pipe sizes. Machine has worm and worm gear drive head and sliding gears providing 2 speeds plus pick-off speed change gears. Baker Brothers Inc., Toledo, O.

ROLL-HANDLING TRUCK. Up-ends paper rolls or other heavy cylindrical objects from horizontal to vertical position or vice versa. Hydraulically-operated arms clamp load for turning. Handles rolls from

Wichita City Librar



How to get UNIFORM quality in your stainless steel forgings

UNIFORM quality in your forgings has to start at the beginning—with the bars you use.

Timken® stainless steel forging bars give you high surface and internal quality that's *uniform* from bar to bar and from heat to heat. You can depend on uniform physical and chemical properties from shipment to shipment. Forgeability is consistent. Costs are cut through fewer rejects, delays and changes in shop practice.

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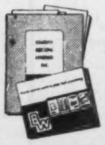

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15 to 31 in. in diameter with special arms available for larger sizes. Capacity, 2000 lb in either gas or electric fork truck models. Clark Equipment Co., Industrial Truck Div., Battle Creek, Mich.

HIGH-LIFT FORK TRUCK. Gas-powered model designed primarily for long-run, outside hauls. Powered by 17-hp, air-cooled engine with generator and starter; includes automotive type transmission, clutch and brake. Overall length with 30-in. fork, 102 in.; width, 32½ in.; max lift, 121½ in., total weight, 3900 lb. Travel speed with 2000-lb capacity load, 6½ mph; lift speed, 31 fpm; lowering speed, 35 fpm. Upright tilts forward 5 degrees, backward 10 degrees. Elwell-Parker Electric Co., Cleveland, O.

SHAPE-CUTTING MACHINE. Handles straight-line, circle and bevel cutting in addition to shape cutting. Oxyacetylene machine includes manual tracing device, torch, tip, track and hose. Cutting area, 32 in. wide by 56 in. long. Track sections enable cutting of longer lengths. Machine weight, 110 lb; weight of tubular rail on which machine travels, 35 lb. Air Reduction Sales Co., New York, N. Y.

BRAKE DRUM SUPERFINISHER. Double-spindle, 2-station machine for automotive type brake drums. Finishes drums from 150 to 30-40 microinches, rms. Produces over 6 drums per minute with 1 operator. Roughing and finishing stones timed to work together as brake drum oscillates and revolves. Spindle cycle is automatic. Gisholt Machine Co., Madison, Wis.

WIRE STRIPPER. For production stripping of insulation from ends of solid, stranded or multiconductor cable or wire to ½-in. diameter. Adjustable stop provides for any length stripping to 1½ in. Circular cutting knives can be rotated slightly to give new cutting edge, or can be easily replaced. Machine direct-connected to ¼-hp motor. The High Speed Hammer Co. Inc., Rochester, N. Y.

PORTABLE ELECTRIC DRILL. Weight, 3½ lb. Capacity, ¼-in. steel or ½-in. wood. Overall length, 7¾ in., diameter, 2¾ in. Alloy steel double-reduction gearing, with first stage gears helical for quiet operation. No-load speed, 1600 rpm. Equipped with Jacobs hex key chuck. Fasco Industries Inc., Rochester, N. Y.

HIGH-SPEED GRINDER. Operates at 38,000 rpm from 110 to 130-volt, a-c or d-c power. For rough and finish grinding with carbide rotary files. Motor cooled by air stream with air velocity of 5400 fpm.

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do More Work at Less Cost

Fawick Air-Ring Clutch or Brake Type E

Fawick Airflex Clutch and Fawick Air-Ring Brake on Toledo Model 597 Power Press at Briggs Manufacturing Co., Detroit, Michigan.

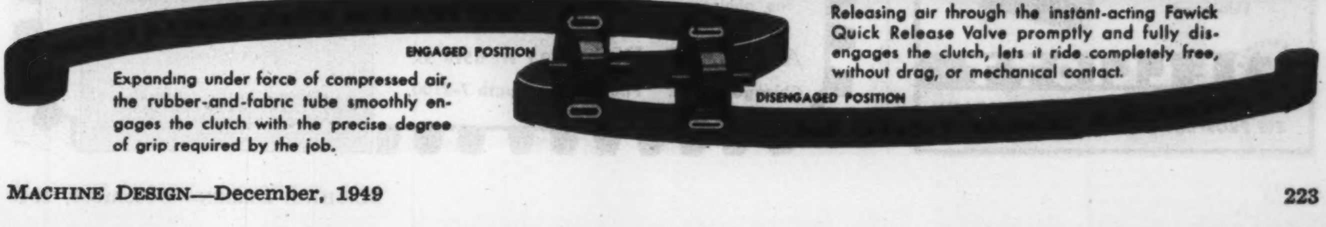
Time-wasting clutch adjustment down time is practically eliminated on Fawick-equipped machines. The moving parts of this Fawick Clutch—the rubber-and-fabric pneumatic tube and the friction shoe assemblies—adjust automatically and compensate for wear.

The smooth engagement action of this Fawick Clutch eliminates sudden shock loads which damage machinery. Controlled torque starting can be obtained with a simple modulating air valve. This type Fawick Clutch is ideally suited to continuous slip applications.

For specific recommendations for your machines, write to our Engineering Department today. Address Dept. MD.

Fawick Airflex Clutch and Brake on one 25x25 and one 24x24 Mill Drive at Dayton Rubber Mfg. Co., Dayton, Ohio.

FAWICK *Airflex* CO., INC.



ENGAGED POSITION

Expanding under force of compressed air, the rubber-and-fabric tube smoothly engages the clutch with the precise degree of grip required by the job.

DISENGAGED POSITION

Releasing air through the instant-acting Fawick Quick Release Valve promptly and fully disengages the clutch, lets it ride completely free, without drag, or mechanical contact.

Weight, 13 oz; length, 6¾ in. Handles 3/32 and ⅛-in. collets. Metal Removal Co., Chicago, Ill.

All-Purpose Hand Tool. Electric drill-saw combines rotary action for drilling, sanding, grinding, etc. with reciprocating motion for sawing, filing, honing, etc. Portable; weighs 6½ lb. Reciprocating motion gives 2000 strokes per minute, 7/16-in. long. Sheldon Products Co., Cleveland, O.

High-Speed Grinder. Pneumatic, 15-oz model for grinding wheels of ½-in. diameter and smaller. Ideal for touching up dies and similar tool room work. Spindle speed, 75,000 rpm. Inverted throttle lever provides operating control. Standard collet takes mounted grinding wheels with ⅛-in. shank. Optional collet chucks take 3/16 or ¼-in. diameter shanks. Keller Tool Co., Grand Haven, Mich.

General Purpose Machine. Heavy-duty, vertical milling, drilling and boring machine. Equipped with variable-speed motors or with constant-speed motors for specialized production work. Table and saddle travel on rollers and are designed to eliminate overhang. Speed and feed changes electronically controlled and may be changed with machine operating. Control panel can be moved to any position convenient to operator. Safety switch on panel stops all machine drives. W. B. Knight Machinery Co., St. Louis, Mo.

Abrasive Cutting Machine. For wet or dry cutting of tubes, angles, bar stock, etc. Handles ferrous or nonferrous materials. Cuts light-wall tubing to 1½-in. diameter and solid bar stock to ¾-in. diameter with 3-hp motor. Cuts light-wall tubing to 2-in. diameter or solid bar to 1-in. diameter with 5-hp motor. Suitable abrasive wheels keep burr to minimum. American Chain & Cable Co. Inc., Bridgeport, Conn.

Press Brakes. High-speed models provide to 80 strokes per minute. Capacity, 35 tons. Die area, 15 by 42 in. Larger tonnages and die areas available. Press-control safety mechanism may be set for continuous operation or to stop at top of stroke. Excessive loads automatically throw out clutch. Machine provides flexible ram setting, low die cost and good operator convenience. The Cyril Bath Co., Cleveland, O.

Horizontal Threading Machine. Double-end, continuous machine for threading both ends of suspension arms. Die heads are carried

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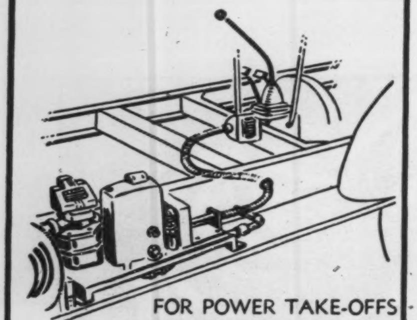

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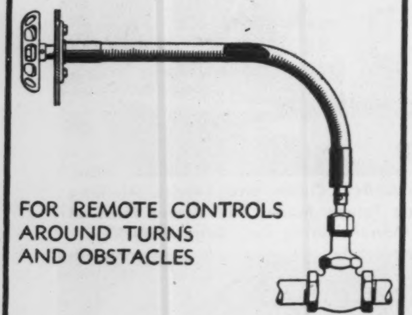

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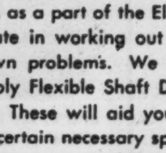

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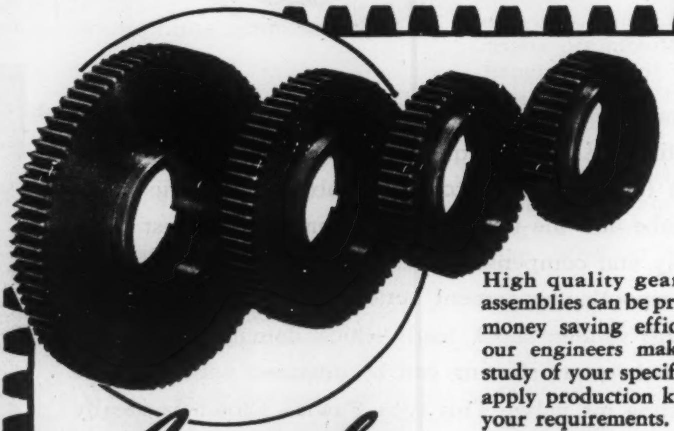

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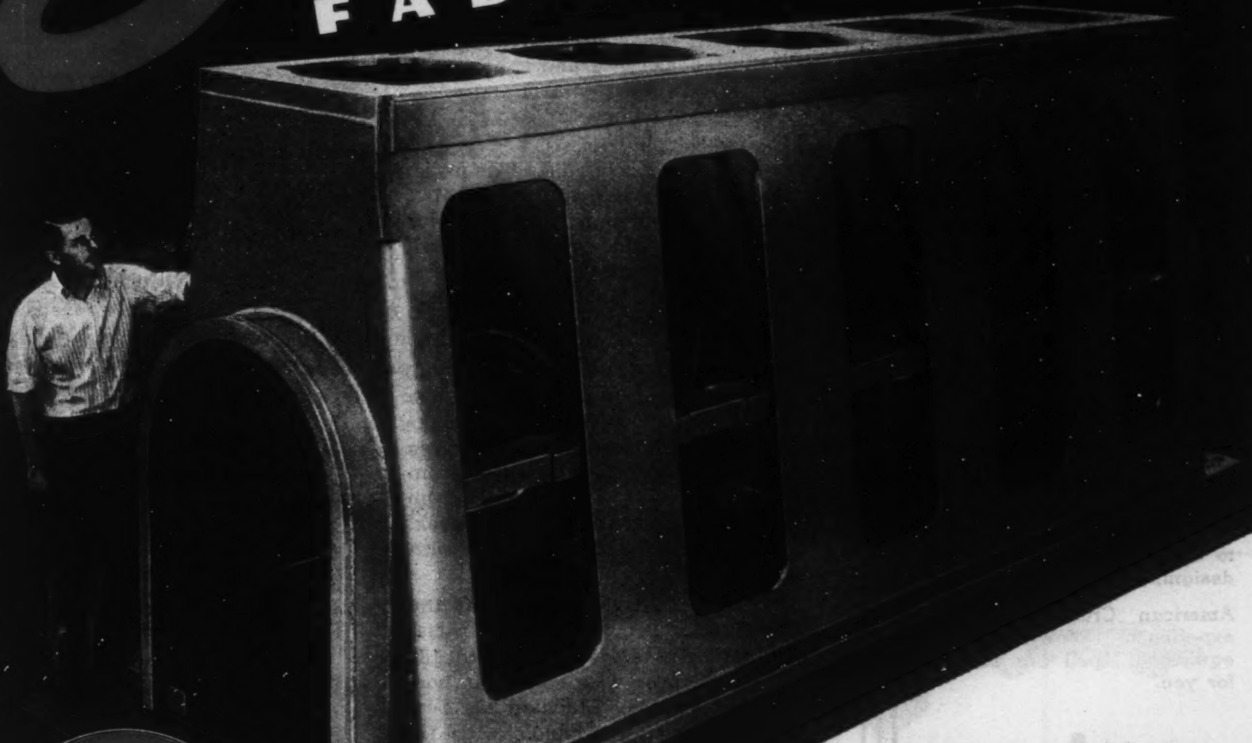

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on each of 12 spindles, 6 on each side, provided with lead screw feed. Workpieces loaded by operator at open station while machine is operating. Production capacity, 1060 suspension arms per hour; up to 1500 pieces per hour possible depending on part. Davis & Thompson Co., Milwaukee, Wis.

Automatic Bending Machine. High-speed, hydraulic machine for bending tube to 3-in. OD with ¼-in. wall thickness (or larger tubes of same area) and other miscellaneous bending. Equipped with 6 automatic stops for various degrees of bend. Machine indexes automatically, bends either right or left with standard dies and can be furnished with hand control and automatic mandrel ejector. Acme-Winter Corp., Buffalo, N. Y.

Lathes. For large diameter work that is not excessively heavy. Max swing over carriage, 24¼ in.; over saddle cross slide with chip guard, 18¾ in. Distance between centers, 30 to 102 in. Includes 16 spindle speeds ranging from 11 to 727 rpm, longitudinal power feeds from 0.0015 to 0.0841-in. per revolution, and cross feeds from 0.0006 to 0.0312-in. per revolution. Quick-change gear mechanism provides 48 pitches of screw threads from 4 to 224 per in. Powered by 2-hp motor mounted under headstock. South Bend Lathe Works, South Bend, Ind.

Universal Drilling And Tapping Machine. Provides 97-in. radial reach; drills holes from 18 to 134 in. above floor with spindle in horizontal position. Machine has 4-in. diameter nitrided spindle with 18-in. manual and power feed, spindle speeds from 25 to 800 rpm, spindle hp of 10 to 20. Spindle head swivels 360 degrees on trunnion, trunnion rotates 180 degrees on rails. Both swiveling units are power driven. Entire rail unit of spindle head, spindle drive and transmission has 60-in. vertical movement on column with rapid traverse up and down. Column base has 48-in. horizontal travel on runway. Choice of 9 spindle feeds and nine speeds. Kaukauna Machine Corp., Kaukauna, Wis.

Turret Lathe. Saddle type universal machine has 21-in. bar and 12-in. chuck capacity. Weight, 4½ tons without tooling. Threading to max turning length with carriage or saddle made possible with full length lead screw. Sliding-gear, quick-change gearbox has single-lever pitch selector. Cross slide and saddle equipped with power rapid traverse; turret is power indexed. Two ranges of 12 spindle

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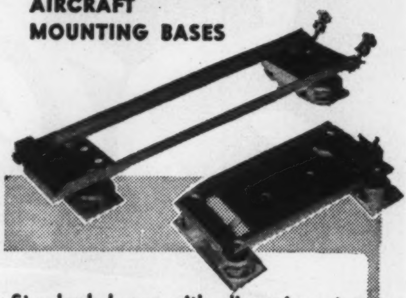

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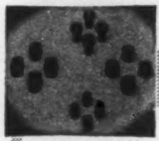

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For electronic components, tiny fractional H.P. motors, record changers, dictating machines, and other light-weight apparatus.

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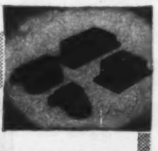

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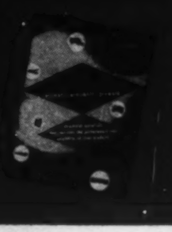
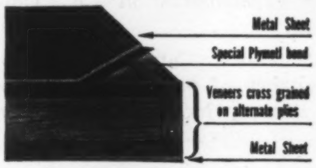


Plymetl *

A lightweight, high quality plywood plaque with light gauge metal sheets permanently bonded to one or both sides. This material has a high *rigid strength-to-weight* ratio, is sound deadening, fire retardant, and high in insulating value. Its flat, smooth metal surfaces take and retain a beautiful finish, free from distorting highlights.



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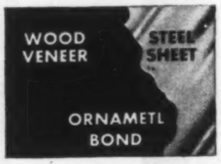
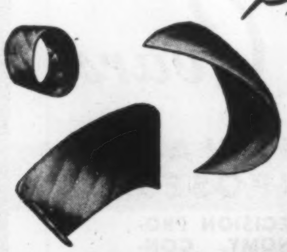
A thin veneer of choice wood is bonded to thin gauge sheet steel. Ornametl is readily adaptable to production methods and equipment used for fabricating sheet metal. It may be stamped, pressed, or rolled to shape. It can be sawed, drilled, punched, and fastened by welding, nailing, or with metal screws or rivets.



Plymold



This process permits molding to either simple or compound curvatures, depending upon the material. Fine plywood and other composite materials such as Haskelite Plymetl and Plastiply have been molded by this process in volume quantity.

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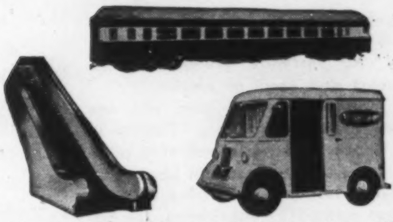
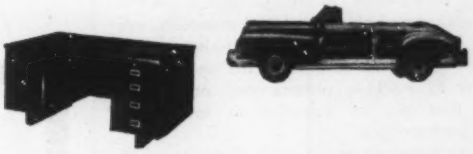
TYPICAL USES

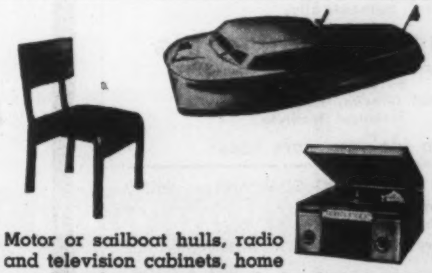


Escalator side panels, interior finish for railway passenger cars. Truck and trailer body panels. Table tops, restaurant counter tops, etc.

"ESCALATOR"—T.M. Reg. by Otis Elevator Company



Office furniture, station wagon side panels, interior finish for passenger cars, house trailers, home or office interiors, and appliances, clocks, magazine racks, decorative ornaments, etc.



Motor or sailboat hulls, radio and television cabinets, home or office furniture, aircraft fuselage, wing and tail assemblies, etc., in volume quantities.

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INJECTION MOLDING PRESS. Hand-operated, low-cost unit for thermoplastic materials moldable between 250 and 500 F. Capacity, ¼-oz. For experimental, test, sample or short-run molding. Thermostatically-controlled heating element built around cylinder where molding materials are heated to flow point. Unit has 3-in. stroke, is 10 in. high; weighs 2 lb. Plastics Development Corp., New York, N. Y.

AIR JET HEATER. Developed primarily for welding and sealing of plastics. Also useful for general laboratory work, spot heating, curing of adhesives, paint removal, etc. Delivers flameless jet of air or gas at temperatures to 700 F and pressures from 5 to 40 psi. Electric heating elements heat air from external source in 3-pass heat exchanger. Unit is portable. DeBell & Richardson Inc., Hazardville, Conn.

PORTABLE SPOT WELDER. Weight, 22 lb. Welds 2 sheets of any weldable 20 to 18 gage steel, galvanized iron, Monel and Hoskins alloys, and stainless steel 2 gages thicker. Optional 220-volt unit welds to ⅛-in. thickness. Dimensions, 4 by 4 by 15 in. Unit requires only 1 hand to operate. Tool & Equipment Distributors, La Grange, Ill.

Materials Handling

TRACTOR-TRUCK. For materials handling in construction or industrial fields. With 2/3-yd capacity dump body, or platform body with removable steel sides and end gates. Includes 3 speeds forward and reverse, max speed of 15 mph, turning radius of 78½ in. Capacity, 3000 lb with 13-hp, air-cooled motor. Wheel base, 56 in. Dimensions: length, 85½ in.; height to top of box, 41¾ in.; width, 42 in.; overall height, 50¼ in.; and ground clearance, 7½ in. Kalamazoo Manufacturing Co., Kalamazoo, Mich.

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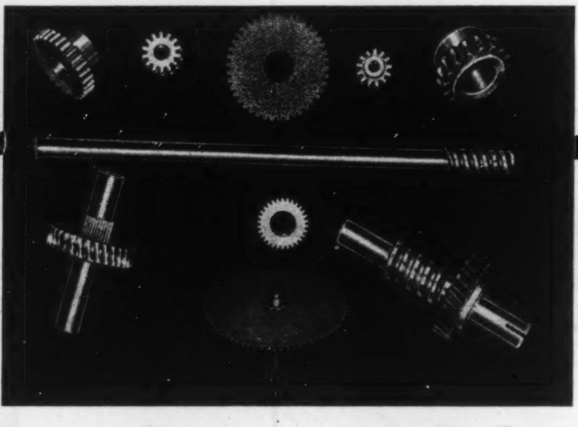

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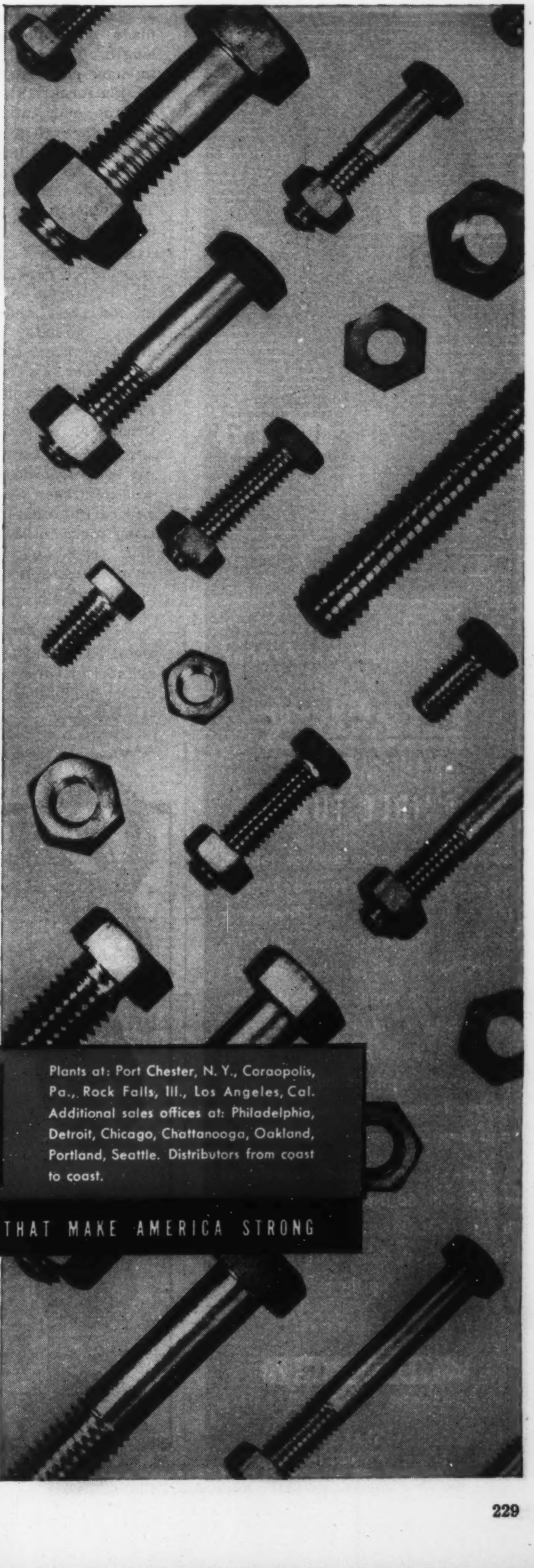

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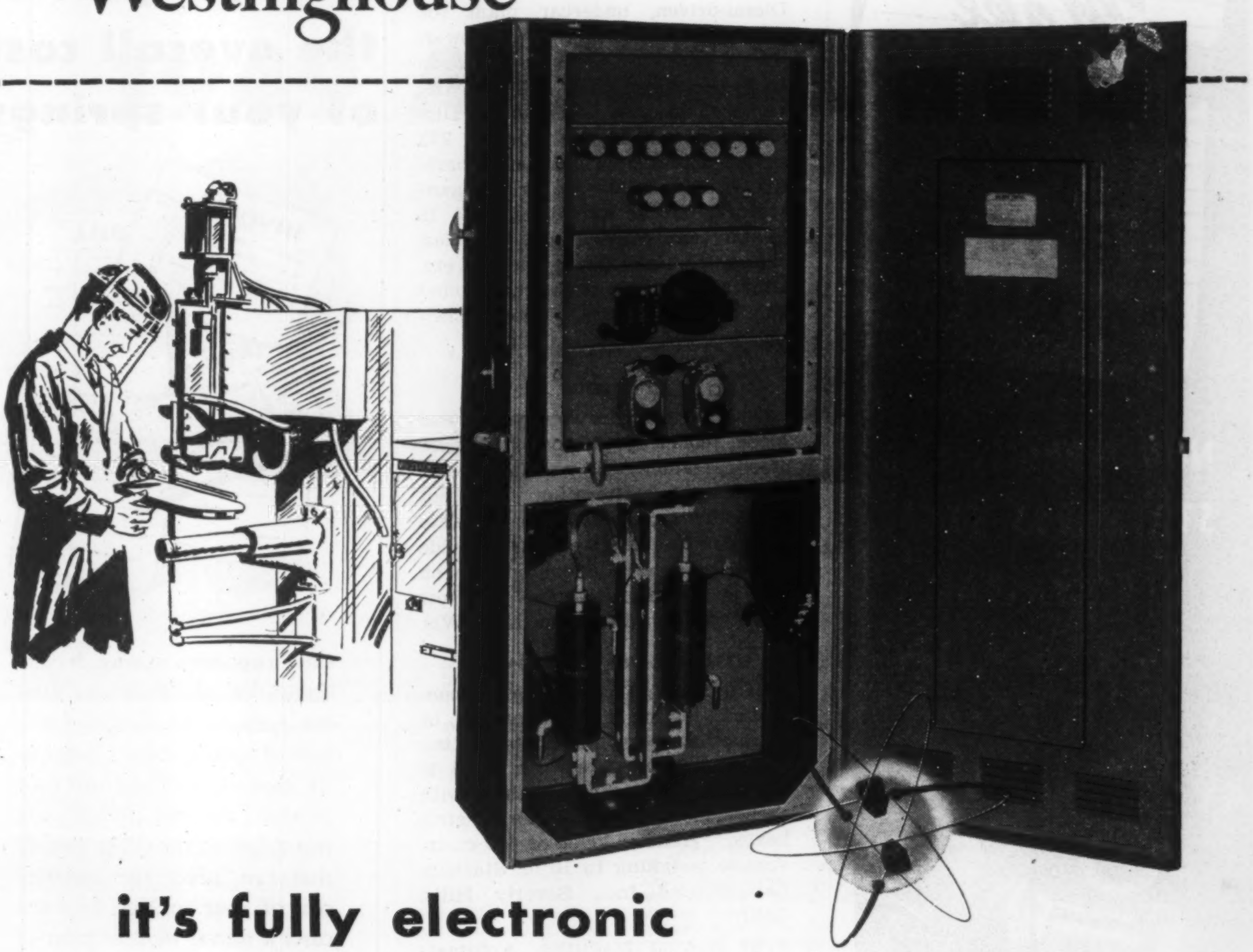

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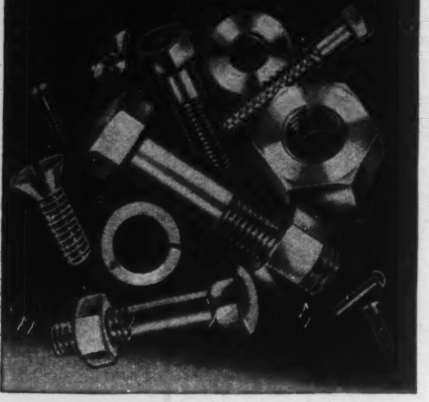

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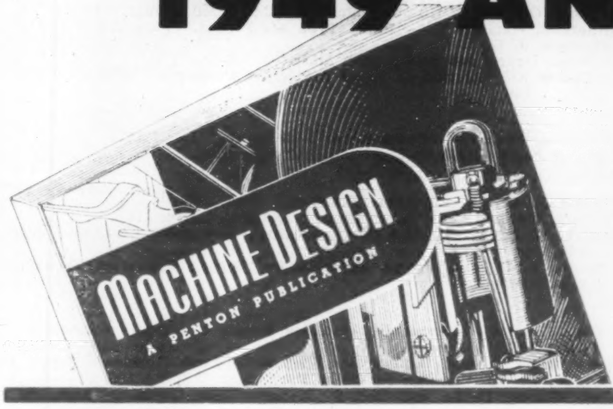
1949 ANNUAL INDEX



Volume 21

January to December

Author Index

Bates, E. L.—"Specifying Design Tolerances," Mar., 120
Beck, Frank—"Centrifugal Stresses in Disks," May, 137
Bennett, J. T.—"The Engineering Manual . . . Its Function and Maintenance," Nov., 99
Blaney, R. E.—"Machine Wraps Shaped Insulation," Oct., 129
Bolz, Harold A.—"Engineering and Shop Relationships," Dec., 102
Bolz, Roger W.
  "Production Processes . . Their Influence on Design:
    "Projection Welding," Jan., 121
    "Butt Welding," Feb., 103
    "Production Brazing," Mar., 107
    "Welding, general considerations," May, 119
    "Welding, design factors," June, 135
    "Sand Castings," Aug., 127
    "Centrifugal Casting," Sept., 107
    "Permanent Mold Casting," Oct., 115
    "Die Casting," Nov., 115
    "Plaster-Mold Casting," Dec., 141
  "Turn Miller," Aug., 90
Bonanno, Joseph L.—"Dollars-and-Cents Advantages of Powder Metal Parts," May, 133
Brkich, A.—"Redesigned for Eye Appeal," Aug., 105
Burg, J. R.—"Mechanized Flame Hardening," Feb., 132

Cain, W.—"Booster Supplies Hydraulic Pressure," Apr., 115
Cohn, Gunther and Jess W. Oren—"Film Pressures in Greased Sleeve Bearings," July, 121
Contaldo, Joseph—"What Size Drive Spindle?" June, 144
Conway, H. D.—"Analyzing Stresses in Shells and Rings," Oct., 122
Conway, H. G.
  "History of Machine Hydraulics:
    "Air Hydraulics," Nov., 106
    "Reciprocating Pumps," Dec., 120
  "Selecting Limits and Machine Parts," Mar., 147
Cummings, Edgar H.—"Stacker Crane," Apr., 103

Dalzell, R. Carson and Joseph J. Matt—"Which Copper-Base Alloy?" Dec., 125
Davis, Louis E.—"Custom Tailor Manual Controls," Sept., 127
Delmonte, John—"Nonmetallic Coatings," Feb., 97
Dodge, Louis—"Design of Round-Bar Clamps," Jan., 115
Dooley, James L.—"Pneumatic Relays," Apr., 109
Douglass, C. N.—"Pneumatic Sander," May, 103.
Drewitz, Edwin—"Knife-Switch Mechanism," Nov., 108
Drucker, Ned—"Getting Flexibility into Machinery," Mar., 129
Durelli, August J. and Rex L. Lake—"Photoelasticity," Nov., 137

Eck, Robert N.—"Automatic Positioning of Machine Spindles," Nov., 111
Edwards, Robert S.—"Selecting Electric Servomotors," Jan., 104
Elberty, Robert S.—"Clutches," May, 98

Fischer, Paul E.—"Dust-Free Drive on Vacuflow Machine," Apr., 139
Freberg, C. R., R. C. Johnson and S. D. Moxley Jr.—"Balancing Crank Mechanisms," Aug., 111
Fry, Macon
  "Determining Recoil Loading," Jan., 93
  "Optimum Diameters of Flexible-Cable Pull Wires," June, 119
  "When Will a Toggle Snap Open?" Aug., 126

Gagne, A. F. Jr.—"Selecting Flexible Couplings," Apr., 117
Garner, W. R. and J. W. Gebhard—"Machine Dials and Scales," Aug., 98
Gatcombe, E. K. and H. S. Ryder—"Designing Vibration Absorbers," Nov., 142
Gebhard, J. W. and W. R. Garner—"Machine Dials and Scales," Aug., 98
Gillett, H. W.—"What Do Materials Tests Tell the Designer?" Oct., 96
Godshall, A. L.—"Compensated Spring System in New Instrument," Mar., 104
Gordon, R. B.—"Investment Casting," Mar., 139.
Guth, Lauren W.—"Creative Engineers," Mar., 89

Hitchcock, Earl B.—"Controlling Machines with Electronic Counters," May, 112
Hofman, W. A.—"Redesign Effects Economies," Jan., 79
Horn, John—"How to Prepare Engineering Reports," Oct., 108
Howard, R.—"Helical Gear Overlap for Smooth Operation," Jan., 145
Hrones, John A.
  "Key Factors in Cam Design and Application:
    "Basic Relationships," Apr., 127
    "Cam Contour Types," May, 107
    "Followers and Follower Systems," June, 124
Hrones, John A. and James B. Reswick—"The Electronic Analogue," Sept., 115

Ireland, James R.—"Permanent Magnets," Apr., 153

Jacobs, R. J.—"Indexing with Concave Barrel Cams," Feb., 93
Johnson, Carl A.—"Helical Gears to Replace Spur Gears," May, 149
Johnson, Clarence—"Air-Hydraulic System Simplifies Design," Apr., 149
Johnson, R. C., C. R. Freberg and S. D. Moxley Jr.—"Balancing Crank Mechanisms," Aug., 111

Karmen, L. J.—"Management Control of New Design," Mar., 127
Kleis, Guy and J. C. McKeon—"Professional Development of the Young Engineers," Dec., 124
Kraus, Charles E.
  "Automatic Positioning and Inserting Devices," Oct., 125
  "Chuting and Orientation in Automatic Handling," Sept., 95
  "Hopper Feeds," Feb., 116

Laird, J. Packard—"Stepping Relays," Apr., 133
Lake, Rex L. and August L. Durelli—"Photoelasticity," Nov., 137
Leifer, L. A. and James A. Mason—"Electromagnetic Clutches," June, 107
Lindsten, M. C.—"Which Fractional-Horsepower Motor?" June, 127
Lotz, Richard K.
  "Bouncing-Basket Washer," Feb., 77
  "Continuous Miner," May, 88
Loveland, R. P.—"Spur Gears," Apr., 161

Maier, Hanns J.—"Reducing Cost of Fatigue Testing," Sept., 137
Martin, James and J. H. Meier—"Improving Analysis of Graphical Records," Mar., 115
Mason, James A. and L. A. Leifer—"Electromagnetic Clutches," June, 107
Matt, Joseph J. and R. Carson Dalzell—"Which Copper-Base Alloy?" Dec., 125
Mazia, Joseph—"Protective Coatings," Jan., 110
McEachron, K. B. Jr.—"Engineering Interns," Aug., 141
McFarland, Forest and J. G. Vincent—"Torque Converter Transmission," July, 117
McKeon, J. C. and Guy Kleis—"Professional Development of the Young Engineers," Dec., 124

Menking, H. V.—"Aluminum Extrusions Design Factors and Tolerances," Nov., 127
Michell, W. P.—"Planetary Gearing," Feb., 87
Mills, Kenneth N.—"Reduction of Noise in Gearing," Jan., 88
Moxley, S. D. Jr., C. R. Freberg and R. C. Johnson—"Balancing Crank Mechanisms," Aug., 111

Nash, William A.—"Calculating Stresses and Deflections in Circular Plates," Aug., 149
Nichols, N. B. and J. G. Ziegler—"Process Control Valves," Jan., 129
Norman, C. A.—"Belt Drives," Feb., 111

Oren, Jess W. and Gunther Cohn—"Film Pressures in Greased Sleeve Bearings," July, 121
Osborn, Niel—"How Codes Affect Pressure Vessel Design," Sept., 105
Otto, Carl Louis—"Engineering by Eye," Mar., 98

Perrin, John G.—"Needed—Nation-Wide Drafting Standard," June, 96
Pfeiffer, Clarence L.—"A More Effective Drafting Room," July, 100

Randich, E. A.—"Strength and Stiffness of Ribbed Plates," Sept., 143
Rappaport, Sigmund—"Design of Beam Scales," June 121
Reed, Ferris L.—"Speed-Control Methods," July, 83
Reswick, James G. and John A. Hrones—"The Electronic Analogue," Sept., 115
Richards, John T.—"What Beryllium Copper Offers the Designer," Aug., 117
Richter, Walter—"Electronic Tachometer," Nov., 133
Ritchie, David—"Molded-Laminated Machine Parts," June, 111
Roberts, C. C.—"Control Instruments," Apr., 169
Robinson, F. W.—"Hydraulic Fitting Standards for Industrial Equipment," (Data Sheet), July, 133
Roman, W. G.—"Electronic Regulators and Regulating Systems," Dec., 147
Ross, Ronald J.—"Differential Pulley Amplifies Vibrograph Output," Oct., 105
Rounds, Thomas E.
  "Superprecision Ball Bearings:
  "Selection for Low Friction, Rigidity and Load Capacity," Jan., 97
  "Shaft Housing and Enclosure Design," Feb., 121
  "Fitting, Installation and Removal," Mar., 131
  "Lubrication and Systems," May, 127
Rupp, Lewis A.—"Applying Pitch-Changing Mechanisms to Marine Propellors," Feb., 127
Ryde, John L.—"Gas Engine Powers Portable Unit," Aug., 106
Ryder, H. S. and E. K. Gatcombe—"Designing Vibration Absorbers," Nov., 142

Schupner, W. J.—"Oscillating Pilot Controls Valve," Aug., 124
Senger, Werner I.—"Determining Balancing Accuracy," Dec., 122
Smith, J. N.—"Hydraulic Packings for Industrial Equipment," (Data Sheet), Dec., 155
Spackman, H. B.—"Co-ordinating Engineering, Production and Sales," Mar., 126
Stimson, Glen H.—"Unified Tolerances Compared," July, 116
Sutherland, Charles R.—"Panel Type Air Filters," July, 125
Swannack, J. D.
  "Beam Deflections Solved with Matrices," Sept., 131
  "Tables Aid Solution of Beam Deflection Problems," (Data Sheet)," Nov., 149

Thompson, Bradley—"Panel Meter Redesigned," Dec., 122
Tyler, Ransom—"Which Hydraulic Pump?" Apr., 141

Vandeman, C. L.—"Machine Finishes," Sept., 99
Varnum, Edward C.—"Relay Circuit Analysis," Dec., 137
Vedder, E. H.—"How and Where to Apply Electronic Controls," Apr., 177
Vincent, J. G. and Forest McFarland—"Torque Converter Transmission," July, 117

Walsh, J. Paul—"Resonance Amplifies Forces in Vibration Machines," July, 113
Weber, Carl F. and William P. Wier Jr.—"Lens Grinder," Sept., 88
Wheelon, O. A.—"Design for Mass Production," Mar., 135
Wier, William P. Jr. and Carl F. Weber—"Lens Grinder," Sept., 88
Wilcock, Donald F.—"Lubrication of Bearings," Nov., 92
Wilkins, W. G.—"Plaster-Mold Castings," June, 114
Wilson, H. A.—"Flywheel Effect of V-Belt Sheaves," Feb., 141
Wilson, Warren E.—"Performance of Hydraulic Pumps and Motors," Jan., 133
Wimer, H. Dudley Jr.—"Motion Analysis," Aug., 109
Winter, Paul H.
  "Acceleration in Geneva Drives," Feb., 130
  "Eliminating Belt Misalignment," Sept., 125

Young, C. H.—"Engineering Graduate in Machine Design," May, 126

Ziegler, J. G. and N. B. Nichols—"Process Control Valves," Jan., 129
Zuefle, Russell G.—"Pretzel Tying Machine," July, 74

Subject Index

A

Acceleration study of geneva drives, Feb., 130
Accelerometer employs spark recording*, Sept., 92
Accelerometer, high frequency (Calidyne Co.)*, Sept., 158
Actuator, electric (Hoover Electric Co.)*, Apr., 196
Adjustable speed drive, electronic, Apr., 177
Air filter, panel type, selection and application in machines, July, 125
Air flow measured by yarn tufts*, Jan., 87
Airplane-helicopter combination*, Apr., 98
Airplane, prone-position pilot bed*, Apr., 98
Algebra, odd-even, for circuit analysis, Dec., 137
Alternators (Kato Engineering Co.)*, July, 140
Amplifier, mechanical, used in vibrograph*, Oct., 107
Analogue, electronic, Sept., 115
Analyzer, noise or vibration (Aircraft Electronics Assoc. Inc.)*, June, 174
Analyzer, servo (Flight Research Engineering Corp.)*, Sept., 158
Antenna, remote training of, Jan., 109
Antidetonant injection for automotive engines*, Feb., 82
Armature, vibratory, operates portable sprayer*, Aug. 147
Atomic power for aircraft*, Nov., 196
Attenuator (Shallcross Mfg. Co.)*, June, 172
Axle, suspension system for*, Aug., 164

B

Backlash eliminator*, Mar., 178
Balancer, viscous*, Oct., 133
Balancing by spring*, Feb., 137
Balancing crank mechanisms, discussion of, Aug., 111
Balancing, determining accuracy of, Dec., 113
Balancing mechanism, Feb., 79
Balls, steel, for ball point pens*, Oct., 92
Beam deflections, table for (Data Sheet)*, Nov., 149
Beam deflections solved with matrices, Sept., 131
Beam scales, design of, June, 121
Bearings, sleeve:
  centrifugally-cast (Induction Processing Co.)*, Nov., 153
  for sliding motion*, Mar., 174
  friction reduced by servo follow-up*, Feb., 82
  heated*, Mar., 176
  high-speed, lubrication of*, Feb., 170
  journal continuously centered by bearing pressure pockets*, June, 155
  locking mechanism for*, Jan., 166
  lubrication at subzero temperatures, Nov., 92
  rubber, in mounted rocker arm*, Dec., 154
  self-aligning (Shafer Bearing Corp.)*, Jan., 147
  self-aligning (Boston Gear Works)*, May, 155
  sleeve, high-density bronze (Ampco Metal Inc.)*, Apr., 184
  tilting pad construction*, Dec., 184
Bearings, ball and roller:
  miniature (Miniature Precision Bearings Inc.)*, Feb., 145
  pillow block (Fafnir Bearing Co.)*, July, 141
  pillow block (Split Ballbearing Corp.)*, Sept., 154
  pillow block (Fafnir Bearing Co.)*, Dec., 163
  pillow block, unit-type (SKF Industries Inc.)*, Nov., 154
  reciprocating (Thomson Industries Inc.)*, Feb., 152
  resilient mount for*, Apr., 108
  roller, take-up (Dodge Mfg. Corp.)*, Aug., 158
  roller, Messinger "X" type, May, 92
  superprecision, Part III—selection for low friction, rigidity and load capacity, Jan., 97; Part IV—shaft, housing and enclosure design, Feb., 121; Part V—fitting, installation and removal, Mar., 131; Part VI—lubrication and systems, May, 127
  take-up (Dodge Mfg. Corp.)*, Sept., 154
  take-up (Fafnir Bearing Co.)*, Mar., 160
  unit (Roberts Machine Works)*, Aug., 152
Belts:
  conveyor for bulk materials between mixing and packaging*, Oct., 104
  conveyor, nylon-cotton combination*, Oct., 92
  drives, operating conditions of, Feb., 111
  eliminating misalignment in drive, Sept., 125
  endless, rubber (U. S. Rubber Co.)*, Oct., 137
  V-belts, fractional horsepower (Browning Mfg. Co.)*, Dec., 165
Blowers:
  electric (Globe Industries Inc.)*, Mar., 159
  electric, reversible (Globe Industries Inc.)*, June, 162
  small (Redmond Co. Inc.)*, June, 164
Bonding agent (Western Sealant Inc.)*, Nov., 155
Bonding, rubber-to-metal (Stalwart Rubber Co.)*, May, 155
Bosses, projection welding (Ohio Nut & Bolt Co.)*, Apr., 188
Bottle filler, high-speed*, Nov., 148
Brakes:
  disk, self-energizing, Nov., 125
  disk-type electric (Warner Electric Brake Co.)*, Nov., 152
  dynamic, adjustable-speed motor, July, 86
  fractional-hp, magnetic (Stearns Magnetic Mfg. Co.)*, July, 141
  hydraulic, dispenses with linkages*, Jan., 85
  motor, solenoid (Guardian Electric Mfg. Co.)*, Oct., 140
  reverse, Jan., 166
  system for hydraulic application, July, 120
Brazing aluminum to steel*, Aug., 86
Bridge and amplifier (Ellis Associates)*, Dec., 172

---

*Denotes short articles of less than one page.

Bushing, linear ball (Thomson Industries Inc.)*, Sept., 151
Bushing, strain relief (Heyman Mfg. Co.)*, July, 144
Business machines, Dec., 150

C

Cabinets, blueprint (Cole Steel Equipment Co. Inc.)*, July, 150
Cabinet, electrical, dust-tight (Square D Co.)*, Jan., 147
Cabinets, steel drawer (Aurora Equipment Co.)*, Sept., 158
Calibration flasher*, May, 97
Camera film advance, motor-driven*, Oct., 132
Camera, microfilm continuous strip (Diebold Inc.)*, Jan., 160
Camera oscilloscope (F. P. Warrick)*, Mar., 170
Cams:
  adjustable track*, Dec., 186
  concave barrel, indexing with, Feb., 93
  cylinder for indexing star wheels*, July, 78
  design and application, Part I—basic relationships, Apr., 127; Part II—contour types, May, 107; Part III—followers and follower systems, June, 124
  profiler*, Sept., 142
  redesign of for Sulzer weaving machine, Jan., 81
Carburetors, horizontal type (Zenith Carburetor Div.)*, May, 154
Carrier, belt conveyor (Stephen-Adamson Mfg. Co.)*, July, 142
Casters, heavy-duty (Bassick Co.)*, Aug., 155
Castings:
  centrifugal, Sept., 107
  die casting, design for, Nov., 115
  investment, beryllium copper, Aug., 119
  investment, case study of, Mar., 139
  investment, for stainless steel crank*, Feb., 140
  iron (Motors & Metals Inc.)*, Dec., 166
  magnesium, Aug., 106
  permanent-mold, Oct., 115
  plaster-mold, June, 115
  plaster-mold, Dec., 141
  sand, copper base alloys for, Aug., 134
  sand, design considerations, Aug., 127
Chain, detachable roller (Atlas Chain & Mfg. Co.)*, July, 144
Chromium plating for small parts (Midwest Chrome Process Co.)*, Feb., 148
Chuting employed in automatic feeding and transfer, Sept., 95
Circuit breaker, automatic reset (Fasco Industries Inc.)*, Dec., 162
Circuit breaker, low voltage, d-c (Spencer Thermostat Div., Metals and Controls Corp.)*, Nov., 154
Circuit breaker plug (Hopax Electric Inc.)*, June, 168
Circuit, inlaid, for sliding contacts (Glass Products Co.)*, Aug., 152
Circuit tester, pocket-sized (Precision Apparatus Co.)*, Apr., 202
Clamps:
  conduit, low-pressure (Flexible Tubing Corp.)*, Jan., 150
  hose, self-tightening (Corbin Screw Div.)*, Apr., 94
  midget-type (Noble & Stanton Inc.)*, July, 143
  round-bar, design of, Jan., 115
  wire harness (Thomas Associates)*, Apr., 194
Clock, based on atomic vibration*, Feb., 84
Clutching, automatic*, Aug., 164
Clutches:
  control, single-stroke*, May, 146
  coupling, centrifugal (Centric Clutch Co.,)*, Nov., 157
  disk type, automatic (Salsbury Corp.)*, May, 160
  eddy-current, used in industrial trucks*, Mar., 97
  electromagnetic, June, 107
  facing, asbestos-metallic (Johns-Manville)*, Nov., 155
  fluid-particle magnetic (Duncan & Bayley Inc.)*, Nov., 152
  friction, automatic (Clark Clutch Div.)*, Jan., 152
  magnetic fluid type, characteristics and design of, May, 98
  mercury-actuated (Automatic Steel Products Inc.)*, Oct., 135
  overload operated*, July, 79
  overrunning, June, 104
  prevents double stroke*, Sept., 136
  self-controlled*, Apr., 212
  spring, sheave type (L.G.S. Spring Clutch Corp.)*, Jan., 147
  system for hydraulic application, July, 120
  torque limiting, Oct., 133
  uses centrifugal flyweights, automatic*, Jan., 168
  V-belt, automatic (W.S.K. Inc.)*, Feb., 145
Coils, heat transfer (Parker Appliance Co.)*, June, 161
Combustion control, electronic (Bristol Co.)*, Oct., 139
Compressor, air (Air-Flo Compressor Co.)*, Apr., 192
Compressor, clean-lined, May, 148
Condensate disposal unit (Eastern Industries Inc.)*, July, 143
Conductor, super, electric*, Apr., 98
Connectors:
  solderless (Thomas & Betts Co.)*, Jan., 148
  wire, plastic and porcelain (Holub Industries Inc.)*, Sept., 146
  wire, screw-on (Holub Industries Inc.)*, Jan., 154
Contact, electrical, copper-tungsten (Gibson Electric Co.)*, Jan., 154
Contact, electrical, materials (Fansteel Metallurgical Co.)*, Mar., 166
Contactors:
  air break (Allis-Chalmers Mfg. Co.)*, Oct., 140
  magnetic (Ward Leonard)*, Mar., 157
  reversing (Struthers-Dunn)*, May, 156
Controls:
  bomber pressure*, May, 106
  circuit, hydraulic, of contour saw, Oct., 134
  circuit transformer (Square D Co.)*, May, 162
  combustion, electronic (Bristol Co.)*, Oct., 139
  electric motor drives, July, 83
  electronic, how and where to apply, Apr., 177
  electronic, motor load, (G.C. Wilson & Co.)*, Apr., 194
  instruments, type and selection, Apr., 169
  instruments, air operated (Bristol Co.)*, Nov., 160
  liquid level, magnetic*, Sept., 164
  manual, selection of, Sept., 127
  photoelectric (Photoswitch Inc.)*, Oct., 137
  plug, electric (Standard Dayton Corp.)*, June, 162
  remote, for radio tuning devices*, Jan., 168
  single-stroke clutch*, May, 146
  solenoid latch, Apr., 105
  speed stepless (Servo-Tek Co.)*, Aug., 156
  systems, air-hydraulic, Apr., 149
  time, hydraulic system (Hufford Machine Works)*, Jan., 148
  timer (Photoswitch Inc.)*, May, 158
Controlling machines with electronic counters, May., 112
Control, tension and velocity*, Nov., 114
Converter, liquid oxygen, July, 99
Converter, liquid oxygen*, May, 84
Converter, transmission, July, 117
Conveyors:
  belt, corrugated surface for 40 degree incline*, July, 68
  belt, for bulk materials between mixing and packaging*, Oct., 104
  belt, overland, May., 138
  belt, zipper edges*, Jan., 76
  chain (Whitney Chain & Mfg. Co.)*, May, 154
  high-speed, analysis of, Aug., 109
Cord, high-strength heater, (General Electric Co.)*, Feb., 154
Corrosion, car underbody, by salt treated roads*, Oct., 166
Corrosion-inhibiting rods (Rotometals Inc.)*, Mar., 164
Counters:
  electronic, for machine control, May, 112
  low-speed, magnetic (Veeder-Root Inc.)*, Aug., 157
  magnetic (Veeder-Root)*, May, 154
  mechanical (Durant Mfg. Co.)*, Apr., 188
  ratchet type (Veeder Root Inc.)*, Nov., 157
Couplings:
  clutch, centrifugal (Centric Clutch Co.)*, Nov., 157
  electrical, waterproof (Roylyn Inc.)*, Aug., 154
  flexible (Boston Gear Works)*, Apr., 184
  flexible (Estey Co.)*, Aug. 153
  flexible (Lord Mfg. Co.)*, Apr., 192
  flexible (Morse Chain Co.)*, Aug., 158
  flexible, gear-type (Sier-Bath Gear & Pump Co. Inc.)*, Sept., 150
  flexible, selection of, Apr., 117
  flexible shaft (Elliot Mfg. Co.)*, Dec., 166
  flexible, silent chain (Morse Chain Co.)*, Sept., 146
  friction, for portable power-driven tools*, Feb., 168
  hydraulic (B. A. Coupling Co. Inc.)*, Sept., 147
  revolving casing for (Diamond Chain Co.)*, Oct., 140
  shaft, wedge-locking (Dodge Mfg. Co.)*, Mar., 157
  swivel pipe joint (Kelite Products Inc.)*, July, 142
Crane, stacker, mounted on overhead rails, Apr., 103
Crank mechanism, balancing of, Aug., 111
Current indicator (Industrial Devices Inc.)*, Nov., 162
Cutout, multigage, automatic (Greer Hydraulics Inc.)*, Nov., 156
Cylinder, air adjustable-stroke (Anker-Holth Mfg. Co.)*, June, 170
Cylinder, carbide, solid (Carboloy Co.)*, Mar., 158
Cylinder, hydraulic, cushion-plate for (Gerotor May Corp.)*, Nov., 155
Cylinder, pneumatic (Tompkins-Johnson Co.)*, Nov., 158

D

Deflection of beams solved with matrices, Sept., 131
Deflections of circular plates (Data Sheet)*, Aug., 149
Detector for leaks in welded tanks*, Oct., 92
Detents, hydraulically-actuated*, Apr., 216
Dials:
  design of, for machines, Aug., 98
  direct reading indicates screw feed*, Jan., 85
  timer (M. H. Rhodes Inc.)*, Apr., 186
Diaphragm, vacuum-actuated, for shutting valve*, Sept., 92
Die casting, design for, Nov., 115
Differentials:
  mechanical*, Dec., 184
  mechanical, controls torque*, Sept., 104
  mechanical, small, (Milwaukee Lock & Mfg. Co)*, Apr., 186
  synchronous (Kollsman Instrument Div.)*, Mar., 162
Disks, centrifugal stresses determined graphically, May, 137
Drafting:
  chair (Cramer Posture Chair Co.)*, July, 152
  format, June, 96
  guide, perspective (Charles Bruning Co.)*, Aug., 160
  instrument (W. J. Ottinger)*, Feb., 160
  instrument (Plastic Enterprise Inc.)*, July, 150
  machine (Charles Bruning Co.)*, Nov., 162
  machine (V & E Mfg. Co.)*, Dec., 170
  machine, precision (L. G. Wright Inc.)*, Oct., 142
  management, July, 100
  standards, June, 96
  table (Engineering Mfg. Co.)*, Feb., 158
  tracing unit, fluorescent (Stacor Equipment Corp.)*, July, 152
Drier, print, electric (Fedco Products)*, Apr., 202
Drier, warm air improves efficiency, Feb., 91
Drilling unit (Black Industries)*, June, 165
Drills, twist*, Aug., 97
Drives:
  dual-motor, for machine control*, Jan., 144
  friction*, Feb., 172
  interrupted-rotation (Metal Seal and Products Inc.)*, Dec., 161
  reciprocating*, June, 155
  spindle, selection of, June, 144

E

Ejector, liquid (Selas Corp. of America)*, Aug., 152
Electrodes, arc-welding (Data Sheet)*, June, 151
Electronic analogue, Sept., 115
Electronic calculator*, June, 92
Electronic controls, how and where to apply, Apr., 177
Electronic regulators and regulating systems, Dec., 147
Electronic transmitter and receiver*, July, 81
Engineering department (see Management)
Engines:
  cyclone*, May, 132
  gasoline (Uebelhoer Bros.)*, May, 156
  gasoline (Briggs & Stratton Corp.)* May, 157
  gasoline, light-weight (Power Products Corp.)*, Mar., 160
  gasoline, lightweight (Simplex Mfg. Corp.)*, Dec., 165
  gasoline, portable (Prentice Corp.)*, June, 162
  gasoline, small (Cushman Motor Works Inc.)*, July, 146
  high-compression*, Dec., 200
  radial, aircraft, improved design of, Oct., 121
  single cylinder, Aug., 106
  vertical shaft type (Clinton Machine Co.)*, Oct., 137
  water-cooled (Cushman Motor Works Inc.)*, Aug., 154

---

*Denotes short articles of less than one page.

Escapement magnetic reed for watches*, Mar., 86
Etching, preparation of metal surfaces for examination*, Sept., 91
Extensometer, continuously-indicating*, Dec., 134
Extrusions, aluminum, design factors and tolerances, Nov., 127

F

Fasteners:
  blind (Tinnerman Products Inc.)*, Apr., 186
  comparison of tolerances, July, 116
  in metal strip (Tinnerman Products Inc.)*, Nov., 154
  locking, heavy-duty (Security Locknut Corp.)*, Nov., 156
  locking, high-temperature (Elastic Stop Nut Corp.)*, Mar., 166
  locking, screw (Brush Nail Expansion Bolt Co.)*, Aug., 153
  multiscrew (American Screw Co.)*, Aug., 151
  rubber-insulated (Automotive Rubber Co.)*, Oct., 138
Fatigue tester, pneumatic*, July, 132
Fatigue testing, accelerated method of, Sept., 137
Feeder, press stock*, Nov., 98
Feeding and transfer devices, automatic, Oct., 125
Feeding mechanism, automatic, for small parts, Sept., 95
Feeds, hopper, basic types and their design, Feb., 116
File, drawing, metal (Empire Development Corp.)*, Mar., 170
Film advance, camera, motor driven, Oct., 132
Film, direct-positive copying (Eastman Kodak)*, Dec., 172
Filter, dual-purpose, cleaning lubricating or fuel oil (W.G.B. Oil Clarifier Inc.)*, Apr., 190
Filter, stainless steel (Amplex Mfg. Co.)*, Nov., 160
Finishes:
  anodizing, discussion of, Jan., 110
  chromate coating, discussion of, Jan., 110
  chromate-phosphate, discussion of, Jan., 110
  chromium plating for small parts, (Midwest Chrome Process Co.)*, Feb., 148
  decorative (Sherwin-Williams Co.)*, June, 168
  machine, Sept., 99
  nonmetallic, characteristics of, Feb., 97
  oxide coating for aluminum, Jan., 110
  paint, corrosion-resistant, plastic (Munray Products Inc.)*, June, 163
  paint, fire-retardant*, Apr., 98
  paint, stainless-steel (Plastics Div., Lockrey Co.)*, May 164
  primer, metal finishing (Di-Noc Co.)*, Sept., 149
  protective (U. S. Stoneware Co.)*, Oct., 138
  protective, phosphate, applied by water solution*, Jan., 76
  vitreous enamels for aluminum alloys*, Apr., 98
  zinc, bright-chromate (Allied Research Products Inc.)*, Feb., 145
Fitting standards, hydraulic (Data Sheet), July, 133
Fittings, tube, July, 106
Fittings, tube, hydraulic (Parker Appliance Co.)*, Jan., 147
Flash lamp, plastic (Amglo Corp.)*, May, 166
Flaws, metal, detected by ultrasonic stethoscope*, Feb., 86
Flexible-cable pull-wires, optimum diameters of, June, 119
Flow-control unit (Hays Mfg. Co.)*, Jan., 150
Fluid flow control*, Mar., 178
Fluid proportioning by helical propeller*, Mar., 174
Force measurement, hydraulics employed in, Oct., 113
Fuse holder, in-line (Hugh H. Eby, Inc.)*, Oct., 140

G

Gages:
  cutout, automatic (Greer Hydraulics, Inc.)*, Nov., 156
  high-pressure (American Machine & Metals Inc.)*, July, 148
  hydraulic, shock-resistant (A. Schrader's Son)*, Mar., 164
  strain, helically-wound*, Aug., 164
  strain, measuring accuracy*, Mar., 95
  thickness (Branson Instruments Inc.)*, June, 172
Gaging, semiautomatic, on gear finishing machine*, Jan., 85
Gasket, flexible, all metal (Flexitallic Gasket Co.)*, Nov., 153
Gasket material (Products Research Co.)*, July, 142
Gasket material, heat resistant (Acushnet Process Co.)*, Oct., 138
Gasket, rubber, punched and extruded (Stalwart Rubber Co.)*, Mar., 168
Gasoline power unit (Cushman Motor Works)*, Feb., 154
Gearing, planetary, discussion of, Feb., 87
Gearmotors (see motors)
Gears:
  helical, overlap for smooth operation (Data Sheet), Jan., 145
  helical to replace spur (Data Sheet), May, 149
  modified tooth form increases efficiency, reduces noise, Jan., 88
  noise reduction of, Jan., 88
  planetary in two-speed bicycle drive, Nov., 132
  shaved, have wear resistance*, Jan., 76
  spur, for high-speed application, Apr., 161
Generator, small, d-c (Arma Corp.)*, Aug., 157
Generator, tachometer (General Electric Co.)*, Nov., 162
Geneva drives, acceleration study, Feb., 130
Germanium crystals, four-element, radio and television*, Oct., 92
Governor, centrifugal (Pierce Governor Co.)*, Sept., 146
Governor, dual speed, of commercial vehicles*, Nov., 168
Graphical analysis, centrifugal stresses in disks, May, 137
Graphical record, improved analysis of, Mar., 115
Grease, gear, extreme-service (Keystone Lubricating Co.)*, Feb., 145
Grease, low temperature (Texas Co.)*, Mar., 158
Grinder has cam shape wheel*, Mar., 95
Grinder, tilting table feed*, May, 145
Grinding, centerless of small ball bearing*, Nov., 96
Gyroscopes, rate and position (G. M. Giannini & Co.)*, June, 161

H

Hardening, flame, mechanized advantages of, Feb., 132
Hardness testing with precision indenter,* Nov., 146
Hard-surfacing powder (Lincoln Electric Co.)*, Feb., 156
Heating elements*, May, 84
Hinges, continuous aluminum (Moynahan Bronze Co.)*, Apr., 192
Hopper feed, automatic (Feedall Machine & Engineering Co.)*, July, 148
Hoppers for parts (Kraus Design Inc.)*, Sept., 150
Hose, air, oil-resistant (B. F. Goodrich Co.)*, Dec., 164
Hose, sanitary, rubber (Goodyear Tire & Rubber Co.)*, Apr., 194
Hydraulics:
  booster, Apr., 115
  booster (Sprague Engineering & Sales)*, Aug., 154
  circuit, for contour saw control, Oct., 134
  control valve, directional (Vickers Inc.)*, Apr., 184
  cylinders (Miller Motor Co.)*, May 155
  fluid, high-temperature (Celanese Corp. of America)*, Nov., 157
  force measurement by, Oct., 113
  machines, history of, air hydraulics, Nov., 106
  machines, history of, reciprocating pumps, Dec., 120
  packings, for industrial equipment, Dec., 155
  pump, Apr., 141
  pump balancing device*, Jan., 170
  pumps and motors, performance of, Jan., 133

I

Ignition systems, low-tension*, Feb., 186
Indicator, engine pressure*, Sept., 156
Indicator, strain, automatic balancing (Baldwin Locomotive Works)*, Oct., 142
Inserts, rolled-thread (Clover Industries Inc.)*, June, 163
Inserts, sapphire, for wear resistance*, Dec., 111
Instruments:
  control, type and selection, Apr., 169
  pivot type, panel (General Electric Co.)*, Oct., 136
  vibration-measuring (Rev Products Co.)*, Feb., 160
Insulation:
  light-weight for cold pipe (Robinson Industries)*, Nov., 156
  plastic foam*, May, 84
  plastic, thermal (American Latex Products Corp.)*, Jan., 158
  resin, silicone (General Electric Co.)*, Sept., 154
  wrapping machine, Oct., 129
Insulators, electrical (American Lava Corp.)*, June, 168

J

Joints:
  double universal operation*, Apr., 218
  high-temperature, swivel (Chiksan Co.)*, Dec., 162
  rotating, high-temperature (Chiksan Co.)*, Oct., 139
  universal (Lovejoy Flexible Coupling Co.)*, May, 164
  universal ball and socket*, Apr., 216

K

Kilovoltmeter (Hickok Electrical Instrument Co.)*, Sept., 158
Knife-switch mechanism, Nov., 108

L

Lamp, flash, triggered by light impulse*, Aug., 146
Landing gear, design features of*, Oct., 170
Lathe, design for rapid setup, automatic changing*, Sept., 140
Lens grinder, Sept., 88
Lettering instrument, mechanical (Varigraph Co. Inc.)*, Jan., 160
Lighting fixture, adjustable (Stocker & Yale)*, Sept., 158
Light-intensity cells*, Apr., 98
Light, position control, Apr., 107
Limits and fits for machine parts, selection of (Data Sheet), Mar., 147
Load and pressure cells (Baldwin Locomotive Works)*, Dec., 172
Load cell, universal (Baldwin Locomotive Works)*, Feb., 158
Lubricant, compressible, for automatic lubrication, Nov., 97
Lubricating oils*, Aug., 86
Lubrication:
  analysis of film pressure, July, 121
  automatic, by means of compressible lubricants*, Nov., 97
  subzero, bearing, Nov., 92
Lubricator, journal box (Miller Felpax Corp.)*, Dec., 162

M

Machines (see specific machines)
Machinery, getting flexibility into, Mar., 129
Magnet, nonmetallic (General Ceramics & Steatite Corp.)*, Nov., 158
Magnetic brake, fractional-hp (Stearns Magnetic Mfg. Co.)*, July, 141
Magnetic counter (Veeder-Root Inc.)*, May, 154
Magnetic drive in pump*, Feb., 140
Magnetic fluid*, July, 80
Magnetic materials, nonconducting (North American Phillips)*, Mar., 162
Magnetic starter (Ward Leonard Electric Co.)*, July, 146
Magnet, permanent, materials*, Oct., 92
Magnets, permanent, design and application of, Apr., 153
Magnifier, illuminated (Stocker and Yale)*, Feb., 158
Magnifier, vernier scale (Stebar Co.)*, June, 174
Management:
  control of new design, Mar., 127
  creative engineers, discovering and developing of, Mar., 89
  development of young engineer*, Dec., 124
  engineering, Aug., 141
  engineering and shop relationship, Dec., 102
  engineering reports, Oct., 108
  engineering, symposium, Mar., 126
  graduate's attitude toward design*, Oct., 174
  manual, function and maintenance of, Nov., 99
  quality control*, Dec., 208
  quality control, purpose of*, Nov., 200
  quality control, tolerances, June, 130
  quality, how to improve*, Dec., 212
Manometer, mercury, high-accuracy, (Taylor Instrument Co.)*, Feb., 146

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*Denotes short articles of less than one page.

Materials:
  aluminum, brazing to steel*, Aug., 86
  beryllium copper, design properties, Aug., 117
  bismuth alloy (Cerro de Pasco Copper Corp.)*, Dec., 168
  bronze, high-density, bearing (Ampco Metal Inc.)*, Apr., 184
  carbide tube (Kennametal Inc.)*, Aug., 155
  carbide cylinders, solid (Carboloy Co.)*, Mar., 158
  carbon-graphite bearing (Pure Carbon Co.)*, Oct., 135
  cement, high-temperature,* June, 92
  ceramics, high-temperature*, Dec., 111
  copper-base alloys (Fansteel Metallurgical Corp.)*, Feb., 150
  copper-base alloys, Dec., 125
  directory of, Oct., 217
  glass, designed to permit silver soldering*, Sept., 91
  glass laminate*, Aug., 145
  gray iron, nodular*, May, 84
  leather, improved wear resistance*, Apr., 98
  leather, properties of*, Jan., 76
  magnetic, nonconducting (North American Phillips)*, Mar., 162
  magnetic, permanent*, Oct., 92
  magnesium used in deep drawn shell*, Mar., 146
  stainless steel alloy (Armco Steel Corp.)*, Sept., 146
  stainless steel, corrosion-resistant (Carpenter Steel Co.)*, May, 157
  stainless steel powder parts (Amplex Mfg. Co.)*, Sept., 145
  stainless steel, sheet and plate (Duriron Co.)* Oct., 139
  steel, alloy cast (Lebanon Steel Foundry)*, Sept., 148
  steel, alloy, free-machining (Joseph T. Ryerson & Son Inc.)*, Jan., 147
  steel, free-machining (Joseph T. Ryerson and Son Inc)*, Dec., 166
  steel, silicon sheet, piercing and blanking of*, Aug., 86
  titanium (E. I. DuPont)*, Mar., 160
  titanium*, May, 84
  tungsten powders*, Apr., 98
Materials, testing of, Oct., 96
Measurement:
  accuracy of, enhanced by mercury isotope*, Feb., 85
  electrostatic and magnetic field, by electron microscope*, Oct., 103
  force, by hydraulics, Oct., 113
Mechanical kidney, Dec., 140
Meters:
  contact-making (Assembly Products Inc.)*, Oct., 142
  electric, miniature (International Instruments Co.)*, Jan., 152
  magnetic, piston suspension*, Mar., 174
  panel, redesign of, Dec., 122
  postage, portable*, Sept., 142
  velocity, for air and gas (Hastings Instrument Co.)*, Sept., 156
  vibration (Calidyne Co.)*, July, 152
Micrometer, (Electro Products Laboratory)*, Mar., 170
Milling, turn, machine, Aug., 90
Miner, continuous, May, 88
Model research airport, May, 118
Molded laminated parts, June, 111
Molding, injection, insert (Gries Reproducer Corp.)*, Jan., 158
Molding, two-color*, Jan., 144
Motion analysis of high-speed conveyor, Aug., 109
Motors:
  a-c induction (Westinghouse Electric Corp.)*, Nov., 160
  a-c, three-speed (Marco Industries Inc.)*, Dec., 156
  a-c, variable-speed delivering variable torques*, July, 68
  angular mounting eliminates belt misalignment, Sept., 125
  business machine (General Electric Co.)*, June, 168
  control, electronic, Apr., 177
  d-c, constant-speed (Amglo Corp.)*, Feb., 148
  d-c, low-voltage, permanent magnet (Haydon Mfg. Co.)*, May, 164
  d-c, miniature (Electro-Aire Inc.)*, Dec., 162
  explosion-proof, (Ruthman Machinery Co.)*, Apr., 184
  floating-rotor, utilized for spindle advance, Dec., 135
  fluid drive (Reuland Electric Co.)*, Sept., 150
  flywheel, loom (General Electric Co.)*, Dec., 165
  fractional-horsepower (Electric Motor Corp)*, Sept., 152
  fractional-horsepower (Hoover Co.)*, Mar., 159
  fractional-horsepower (Redmond Co. Inc.)*, May, 160
  fractional-horsepower, selection of, June, 127
  fractional-horsepower, shaded-pole (Electro Engineering Products Co.)*, Jan., 154
  fractional-horsepower, six-pole (Fasco Industries Inc.)*, Nov., 160
  gearhead (Redmond Co.)*, Aug., 157
  gearhead-reduction (Robbins & Myers Inc.)*, Nov., 154
  gearmotors, totally-enclosed (Crocker-Wheeler Electric Mfg. Co.)*, May, 158
  gearmotors, totally enclosed (United Electric Machinery Co.)*, June, 162
  hydraulic, performance of, Jan., 133
  induction, fan-cooled (Burke Electric Co.)*, Feb., 148
  intermittent rotation mechanism for electric*, Jan., 166
  jet pump (Brown-Brockmeyer Co.)*, May, 158
  lifetime lubricated (General Electric Co.)*, Dec., 161
  polyphase, drip-proof (Wagner Electric Corp.)*, Feb., 152
  pump unit (John S. Barnes Corp.)*, Sept., 148
  shaded-pole (Redmond Co.)*, June, 164
  single-phase (Louis Allis Co.)*, July, 144
  single-phase jet pump (Century Electric Co.)*, June, 160
  single-phase (Iron Fireman Mfg. Co.)*, Dec., 164
  small skeleton (Redmond Co.)*, Sept., 149
  submersible pump (Piqua Machine & Mfg. Co.)*, Nov., 155
  synchronous (Electric Indicator Co.)*, Sept., 154
  synchronous timing (R. W. Cramer Co.)*, Oct., 135
  totally-enclosed (Brown-Brockmeyer Co.)*, Sept., 154
  totally-enclosed (Sterling Electric Motors Inc.)*, Sept., 151
  toatlly-enclosed fan-cooled (Valley Electric Corp.)*, Sept., 146
  wound-rotor (Crocker-Wheeler Electric Mfg. Co.)*, June, 166
Mounts:
  adjustable, for appliances (Ohio Nut & Bolt)*, Mar., 168
  resilient, for ball bearings, Apr., 108
  vibration, all-metal (Robinson Aviation Inc.)*, Feb., 156
  vibration, heavy-duty (Finn & Co.)*, Feb., 152
  vibration, snubbing (Lord Mfg. Co.)*, Jan., 148

N

Nameplates, embossed-metal (Chicago Car Seal Co.)*, Mar., 168
Noise analyzer (Aircraft Electronics Associates Inc.)*, June, 174
Nuts and screws, welding (Ohio Nut & Bolt Co.)*, July, 140
Nut retainer (Tinnerman Products Inc.)*, Mar., 166
Nut, snap, blind (Prestole Corp.)*, Jan., 152

O

Oiler, gravity-feed, multiple (Oil-Rite Corp.)*, Jan., 150
Oil seal, rotary (Gits Brothers Mfg. Co.)*, Apr., 184
O-rings, groove design for*, May, 176
Oscillograph, cathode-ray (Allen B. DuMont Laboratories Inc.)*, Dec., 168
Oscilloscope (Hickok Electrical Instruments Co.)*, July, 150
Overdrive for Chevrolet, Apr., 175
Overload detecting device (Westinghouse)*, Mar., 158
Oxygen converter, July, 99

P

Packing, asbestos sheet (Greene, Tweed & Co.)*, Sept., 147
Packing, hydraulic, for industrial equipment, Dec., 155
Packing material, molded (Crane Packing Co.)*, Nov., 156
Packing, ring, nonextruding (Greene, Tweed & Co.)*, Feb., 152
Packing, V-type (Linear Inc.)*, Dec., 161
Panel instruments, pivot type (General Electric Co.)*, Oct., 136
Paper coating machine*, Feb., 139
Permanent magnets, design and application of, Apr., 153
Photocopy machine (General Photo Products Co.)*, June, 172
Photocopy machine, continuous (American Photocopy Co.)*, Apr., 198
Photocopy machine (Haloid Co.)*, Dec., 168
Photocopy paper (General Photo Products Co.)*, Mar., 170
Photocopy paper (Eastman Kodak Co.)*, Apr., 204
Photoelastic method of stress analysis, Nov., 137
Photoelectric control (Photoswitch Inc.)*, Mar., 159
Photoelectric control (Photoswitch Inc.)*, Oct., 137
Photoelectric counter (Photoswitch Inc.)*, Mar., 164
Photoelectric registration control (Photoswitch Inc.)*, Feb., 154
Photography, high-speed, used to analyze casting techniques*, Jan., 76
Photographic viewfinder*, Aug., 86
Pitch-changing mechanism, application to marine propellers, Feb., 127
Pistons, checking and classifying of*, May, 96
Piston ring, taper face, oil control and reduced blow-by*, Apr., 216
Piston temperature measured at high-speed*, Mar., 97
Planetary gear units, May, 92
Plastic and porcelain wire connectors (Holub Industries Inc.)*, Sept., 146
Plastic coating, colored (Foster & Kester)*, Nov., 158
Plastics:
  acrylic fiber*, Jan., 76
  failure of, Mar., 184
  flash lamp (Amglo Corp.)*, May, 166
  housing enhances design*, Aug., 148
  laminate (B. F. Goodrich Chemical Co.)*, Sept., 145
  laminate (Formica Co.)*, July, 146
  laminated parts, June, 111
  nylon-cotton for heavy-duty conveyor belt*, Oct., 92
  nylon, graphite-filled (Polymer Corp.)*, Aug., 157
  phenolic laminate, high-strength (Synthane Corp.)*, Oct., 135
  phenolic, thermosetting (Rogers Corp.)*, Sept., 152
  phenolic used in pump casings*, Mar., 146
  silicone extruded molded parts (Stalwart Rubber Co.)*, Jan., 158
  silicone insulating resin (General Electric Corp.)*, Sept., 154
  silicone-rubber, glass reinforced sleeving (Connecticut Hard Rubber Co.)*, Jan., 156
  silicone rubber parts (Stalwart Rubber Co.)*, June, 170
  silicone-rubber sponge for gaskets, vibration of (Connecticut Hard Rubber Co.)*, Feb., 152
  wire, glass fiber sleeving (Bently, Harris Mfg. Co.)*, Sept., 150
Plates, circular, stresses and deflections in (Data Sheet)*, Aug., 149
Plates, ribbed, strength and stiffness of (Data Sheet)*, Sept., 143
Plugs, countersunk pipe (J. J. Tourek Mfg. Co.)*, Sept., 150
Plugs, leakproof pipe, (U. S. Pipe & Fittings)*, Mar., 160
Pneumatic:
  chip remover, June, 106
  fatigue tester*, July, 132
  industrial wheel (Geneva Metal Wheel Co.)*, Apr., 196
  relays, Apr., 109
  rotary vane pump (Gast Mfg. Corp.)*, Oct., 138
  sander, May, 103
  timer (Square D Co.)*, May, 156
  vibrator (Cleveland Vibrator Co.)*, July, 140
Pneumatic-hydraulic control system, Apr., 149
Polariscope for photoelastic testing, Nov., 138
Porcelain and plastic wire connectors (Holub Industries Inc.)*, Sept., 146
Porcelain enamel, method for evaluating texture*, June, 92
Positioning, automatic, of machine spindles, Nov., 111
Powder-metal parts, dollars-and-cents advantages of, May, 133
Powder-metal parts, stainless steel (Amplex Mfg. Co.)*, Sept., 145
Power system, d-c (Leece-Neville Co.)*, Apr., 190
Power units, hydraulic-electric (American Blower Corp.)*, Feb., 156
Power units, rotating pipe*, Feb., 86
Pre-amplifier, calibrated (Sound Apparatus Co.)*, Dec., 172
Press, air-operating, Jan., 141
Pressure cells, low-range (Baldwin Locomotive Works)*, May, 164
Pressure control, bomber*, May, 106
Pressure measuring device (Automatic Temperature Control Co.)*, Feb., 154
Pressure regulator (C. A. Norgren Co.)*, July, 140
Pressure vessels, how code effects design, Sept., 105
Pretzel tying machine, July, 74
Print drier (Lott Mfg. Co.)*, Apr., 202
Print drier, electric (Fedco Products)*, Apr., 202
Production, design for, mass, Mar., 135
Production:
  Processes, their influence on design, Part XL—projection welding, Jan., 121; Part XLI—butt welding, Feb., 103; Part XLII—production brazing, Mar., 107; Part XLIII—welding, general consideration, May, 119; Part XLIV—welding, design factors, June, 135; Part XLV—sand castings, Aug., 127; Part XLVI—centrifugal casting, Sept., 107; Part XLVII—permanent-mold casting, Oct., 115; Part XLVIII—die casting, Nov., 115; Part XLIX—plaster-mold casting, Dec., 141

---

*Denotes short articles of less than one page.

Prefiler, cam*, Sept., 142
Projection mechanism for movies over television*, Sept., 93
Propeller blades, stainless steel, helicopter*, July, 82
Propellers, reversible pitch, allow high descent rates*, Jan., 76
Pulley, cast-iron, V-belt (A & A Machine Co.)*, Apr., 192
Pulley, differential, amplifies vibrograph output, Oct., 105
Pulley, idler (Palmer Bee Co.)*, May, 164
Pull-wires, optimum diameters of, June, 119
Pumps:
  air, rotary vane (Gast Mfg. Corp.)*, Oct., 138
  centrifugal (Eastern Industries)*, Mar., 157
  centrifugal (Thompson Products Inc.)*, June, 164
  centrifugal (Graymills Corp.)*, May, 160
  centrifugal, stainless steel (Goulds Pumps Inc.)*, Dec., 165
  centrifugal, testing of, Sept., 113
  clutch-driven heavy-duty (Marine Products Co.)*, Jan., 152
  fluid, medium-pressure (Eastern Industries)*, Jan., 156
  gearless hydraulic (Eco Engineering Co.)*, June, 161
  gear-type, hydraulic (Eastern Industries Inc.)*, Nov., 158
  high-head jet (Goulds Pumps Inc.)*, Apr., 194
  high-vacuum*, Feb., 138
  hydraulic, Apr., 141
  hydraulic (Universal Machinery Co.)*, June, 166
  hydraulic (Vickers Inc.)*, Sept., 151
  hydraulic, adjustable-stroke, June, 105
  hydraulic, gear (Hydraulic Equipment Co.)*, Jan., 154
  hydraulic, air-actuated (Lyon-Raymond Corp.)*, Dec., 163
  hydraulic, and motors, performance of, Jan., 133
  hydraulic, piston (Eastman Pacific Co.)*, Jan., 158
  jacketed (Viking Pump Co.)*, July, 140
  reciprocating, Dec., 120
  redesigned inlet ports*, Nov., 168
  restyled for appearance and performance*, Sept., 141
  rotary gear, hydraulic (Lear Inc.)*, Sept., 152
  rotary hydraulic (Hinckley Technical Assoc. Inc.)*, Sept., 149
  rotary vane and rubber seal joint*, May, 176
  two-stage, operates press*, Nov. 147
  water injection (Lear Inc.)*, June, 168
Pump motor (Ruthman Machinery Co.)*, Apr., 184
Pump motor unit (John S. Barnes Corp.)*, Sept., 148
Pyrometer, recording (Electric-Arc Inc.)*, July, 148

Q

Quality control*, Dec., 208
Quality control, purpose of*, Nov., 200
Quality control, tolerances, June, 130
Quality, how to improve*, Dec., 212

R

Ratchet mechanism*, June, 155
Recoil loading, determination of, Jan., 93
Record changing mechanism, phonograph, June, 150
Recorders:
  electric pyrometer (Electric-Arc Inc.)*, July, 148
  graphic (Sound Apparatus Co.)*, July, 152
  operating-time (Bristol Co.)*, Mar., 157
  polinear, for electro-acoustic and electronic devices (Sound Apparatus Co.)*, Oct., 142
  sound analyzer (Sound Apparatus Co.)*, June, 172
  spark, on accelerometer*, Sept., 92
  temperature (Leeds & Northrup Co.)*, Apr., 196
Recording instrument, operation (Bristol Co.)*, Feb., 146
Records, graphical, analysis of, Mar., 115
Rectifiers, heavy-duty selenium (International Rectifier Corp.)*, Apr., 194
Redesign effects economies, Jan., 79
Reducer, geared speed (Euclid Universal Machine Inc.)*, May, 154
Reducer, single reduction speed (Ohio Gear Co.)*, May, 154
Reel windup control*, Apr., 168
Regulators:
  constant flow, Dec., 112
  pressure (C. A. Norgren Co.)*, July, 140
  voltage, automatic (The Superior Electric Co.)*, Sept., 152
  voltage, static generator (Vickers Electric Div.)*, Aug., 152
Relays:
  circuit analysis for, Dec., 137
  compensating (Sigma Instruments Inc.)*, July, 148
  control, miniature (American Relay & Controls Inc.)*, Dec., 164
  general purpose (Advance Electric & Relay Co.)*, Aug., 156
  hermetically-sealed (Advance Electric & Relay Co.)*, Mar., 168
  hermetically-sealed (Automatic Electric Sales Corp.)*, Aug., 153
  magnetic (Ward Leonard Electric Co.)*, Oct., 139
  magnetic (Ward Leonard Electric Co.)*, June, 166
  magnetic, miniature (Ward Leonard Electric Co.)*, Jan., 156
  mercury (Ebert Engineering & Mfg. Co.)*, June, 161
  mercury, double-flow (Durakool Inc.)*, Feb., 152
  pneumatic, Apr., 109
  stepping, Apr., 133
  ultra-high-speed (Stevens Arnold Inc.)*, Apr., 192
Reports, engineering, preparation of, Oct., 108
Resistor coil (Euclid Electric & Mfg. Co.)*, Dec., 163
Resistor, high-current (Ward Leonard Electric Co.)*, Nov., 156
Resistor, high-current (Exmet Electrical Corp.)*, Dec., 164
Resolvers, precision, electric (Arma Corp.)*, Oct., 138
Retainer, self-locking (Waldes Kohinoor Inc.)*, June, 163
Retaining ring, bowed (Waldes Kohinoor Inc.)*, May, 164
Ribbon-wire shapes, metal (Sylvania Electric)*, Mar., 160
Rings:
  sealing, carbon-graphite (Gits Bros. Mfg. Co.)*, Oct., 137
  stainless steel, piston (Steel or Bronze Piston Ring Corp.)*, Sept., 148
  stress analysis of, and shells, Oct., 122
Rods, connecting*, Sept., 94
Rubber:
  belts, endless (U. S. Rubber Co.)*, Oct., 137
  closed cellular (Great American Industries Inc.)*, Aug., 158
  extruded and molded (Stalwart Rubber Co.)*, May, 158
  parts, colored*, Nov., 88
  plasticized compound (Stalwart Rubber Co.)*, Oct., 136
  punched products (Stalwart Rubber Co.)*, June, 160
  silicone parts (Stalwart Rubber Co.)*, June, 170
  solvent-resistant (Stalwart Rubber Co.)*, Mar., 158
  synthetic (Stalwart Rubber Co.)*, June, 164
  synthetic (Stalwart Rubber Co.)*, Dec., 165
  synthetic, compared with natural*, Oct., 168

S

Sander, pneumatic, May, 103
Saw, chain, powered by gasoline engine, Aug., 106
Scales, all-purpose (Omicron Instrument Co.)*, Apr., 204
Scales and dials for machines, Aug., 98
Scales, beam, design of, June, 121
Screws:
  cap, self-locking (Diamond Head Screw Co.)*, Apr., 194
  cap, self-tapping (Parker-Kalon Corp.)*, Nov., 157
  locking inserts (Brush Nail Expansion Bolt Co.)*, Aug., 153
  thread standards, unified, Jan., 127
  welding (Ohio Nut & Bolt Co.)*, July, 140
Seals:
  annular, designed to permit fluid supply to operating chambers*, Nov., 168
  for swivel joints*, Mar., 176
  high-pressure, mechanical (Byron Jackson Co.)*, Dec., 163
  hydraulically closed*, Feb., 170
  O-rings, long-life design*, Feb., 170
  piston-ring*, Apr., 214
  reed*, Sept., 164
  ring, carbon-graphite (Gits Bros. Mfg. Co.)*, Oct., 137
  self-lubricating, carbon-graphite (Morganite Inc.)*, Oct., 139
Sealing of powder-filling machine, Apr., 139
Servo mechanism, clutch-brake (Buehler & Co.)*, July, 142
Servomechanism test instrument (Servo Corp. of America)*, May, 166
Servomotor (Holtzer-Cabot Inc.)*, May, 157
Servomotor (Square D Co.)*, May, 160
Servomotors, Jan., 104
Servo test instrument (Flight Research Engineering Corp.)*, Mar., 172
Shaft control, precision device, Feb., 168
Shaft, telescoping, May, 91
Sheaves:
  steel, two-element (Transmission Machinery Corp.)*, Jan., 148
  torque limiting feature, Oct., 134
  V-belt (V-Belt Engineering Co.)*, Aug., 153
  V-belt, flywheel effect of (Data Sheet), Feb., 141
Shells and rings, stress analysis of, Oct., 122
Shock absorbers*, May, 84
Shock absorbers (Thompson Electric Co.)*, July, 141
Slide rule, circular (Allegheny Plastics Inc.)*, May, 166
Slide rule, log-log (Pickett & Eckel Inc.)*, Dec., 168
Solenoid air valves (see Valves)
Solenoid with increased tractive force*, Sept., 164
Solenoid latch mechanism, Apr., 105
Sound analyzer, recorder (Sound Apparatus Co.)*, June, 172
Sound level meter, portable (Hermon Hosmer Scott Inc.)*, May, 166
Specifications*, Dec., 204
Speed control methods for electric motor drives, July, 83
Speed control, stepless (Servo-Tek Co.)*, Aug., 156
Speed drive, variable (Speed Selector Inc.)*, Aug., 155
Speed drive, miniature (Metron Instrument Co.)*, June, 166
Speed reducers:
  double-reduction, Apr., 167
  double-reduction (Euclid Universal Machine Inc.)*, Sept., 145
  used in pug mill*, Mar., 146
  worm-gear (Boston Gear Works)*, Jan., 154
Spindle drive, calculations for stresses in, June, 144
Spindle drive, selection of, June, 144
Spring system, compensated in instruments, discussion of, Mar., 104
Spur gears, for high-speed application, Apr., 161
Starters:
  magnetic (Arrow-Hart & Hegeman)*, Mar., 158
  magnetic (Ward Leonard Electric Co.)*, July, 146
  magnetic and contactor (Trumbull Electric Mfg. Co.)*, Feb., 152
  solenoid-operated (Ward Leonard Electric Co.)*, Feb., 148
Stoker, spreader type*, Jan., 143
Strain indicator, automatic balancing (Baldwin Locomotive Works)*, Oct., 142
Stress analysis in shells and rings, Oct., 122
Stress analysis, photoelastic method. Nov., 137
Stress, centrifugal, in disks, analyzed graphically, May, 137
Stress, internal, measured by instruments*, Nov., 96
Stroboscope, slow speed (General Radio Co.)*, June, 174
Styling, modern machine*, Feb., 188
Styling of machine, discussion of, Mar., 98
Switches:
  actuating, splashproof (Productions Instruments Co.)*, Jan., 140
  adapter plate for (Unimax Switch Corp.)*, June, 164
  centrifugal*, May, 97
  centrifugal (Euclid Electric & Mfg. Co.)*, Sept., 150
  industrial safety (Square D Co.)*, Sept., 147
  lever-action (Switchcraft Inc.)*, Sept., 151
  limit, duplex (Square D Co.)*, Feb., 150
  motor-reversing (Iron Fireman Mfg. Co.)*, Sept., 148
  precision (Unimax Switch Corp.)*, May, 162
  pressure-actuated (DiaPhlex Div. of Cool Electric)*, Mar., 162
  pressure-actuated (Meletron Corp.)*, Aug., 155
  pressure-relief, Nov., 108
  rotary, multipole, multistage (Electro Switch Corp.)*, Jan., 152
  rotary selector (Arrow-Hart & Hegeman Electric Co.)*, Nov., 153
  slide (Stackpole Carbon Co.)*, Jan., 147
  snap, universal type (Unimax Switch Div.)*, Mar., 164
  stepping, automatic, rotary (Automatic Electric Co.)*, Jan., 152
  stepping, spring-driven (C. P. Clare & Co.)*, Mar., 164
  thermal (Airite Products Co.)*, July, 143
Synchro transmitter, high-sensitivity (Kollsman Instrument Div.)*, Jan., 156
Synchro units (Arma Corp.)*, Feb., 154

T

Tachometers:
  breaker-point, engine (Metron Instrument Co.)*, Apr., 198
  direct-reading (O. Zernickow Co.)*, Apr., 200

---

*Denotes short articles of less than one page.

Tachometers (cont.)
  electric, built-in (Electric Tachometer)*, Jan., 156
  electric, high-precision (Metron Instrument Co.)*, Jan., 160
  electronic, Nov., 133
  indicator (Metron Instrument Co.)*, Mar., 168
  motor testing (Metron Instrument Co.)*, Aug., 160
Television has interoffice use*, Jan., 76
Templates:
  circle (Rapidesign Inc.)*, Feb., 160
  drafting (Rapidesign Inc.)*, Mar., 170
  master, ellipse (Rapidesign Inc.)*, Aug., 160
Temperature recorder (Leeds & Northrup Co.)*, Apr., 196
Temperature transmitter (Taylor Insurument Co.)*, July, 146
Terminal block (Westinghouse Electric Corp.)*, Dec., 166
Terminal, electrical, plug-in (Ark-Les Switch Corp.)*, Apr., 196
Terminals, hermetically-sealed (General Ceramics & Steatite Corp.)*, Apr., 188
Tester, circuit, pocket-sized (Precision Apparatus Co.)*, Apr., 202
Testing:
  cavitation, apparatus, June, 105
  centrifugal pumps, Sept., 113
  fatigue, accelerated method of, Sept., 137
  materials, value of data derived from, Oct., 96
  machine, aircraft*, Jan., 120
  machine, electronic, Jan., 140
  machine, fatigue, subjects pipes to bending loads*, Jan., 86
  machine, vibration, July, 113
  ultrasonic (Sperry Products Inc.)*, Dec., 170
Test instrument, servomechanism (Servo Corp. of America)*, May, 166
Tetrode, power, air-cooled*, Mar., 164
Thermometer element, wafer type (Ruge-de-Forrest)*, Mar., 164
Thermometer, magnetic (W. C. Dillon & Co.)*, Sept., 156
Thermostat, midget disk type (Stevens Mfg. Co. Inc.)*, Nov., 154
Thermostat, positive operating (Stevens Mfg. Co. Inc.)*, Sept., 147
Thermostat, positive-operating (Stevens Mfg. Co. Inc.)*, Dec., 163
Thermostat, protective (Metals & Controls Corp.)*, Oct., 136
Thickness measuring machine*, July, 131
Thread roller, planetary, utilizes triple dies*, July, 130
Thyratron, mercury-vapor (Radio Corp. of America)*, Feb., 150
Timers:
  automatic control (Eagle Signal Corp.)*, Aug., 157
  automatic reset (Haydon Mfg. Co.)*, May, 162
  dials (M. H. Rhodes Inc.)*, Apr., 186
  four-circuit, cycle (R. W. Cramer Co.)*, June, 170
  interval (General Electric Co.)*, Apr., 198
  pneumatic (Square D Co.)*, May, 156
  process (Struthers-Dunn Inc.)*, Apr., 186
  repeat cycle (G. C. Wilson & Co.)*, July, 150
  two-speed (M. H. Rhodes Inc.)*, Aug., 160
Timing unit, electric (Eagle Signal Corp.)*, Apr., 186
Toaster, automatic*, May, 147
Toggle, snap-open calculation*, Aug., 126
Tolerances, comparison of old & new screw-thread standards, July, 116
Tolerances, specifying by statistical analysis, Mar., 120
Tool lifter, automatic electromagnetic (Deca Co.)*, Jan., 154
Torque converter*, Dec., 216
Torque converter, one-way locking system*, May, 178
Torsion scraper ejector, Mar., 142
Transfer and feeding mechanism, automatic, Oct., 125
Transfer forms (C. M. Johnson Co.)*, Feb., 158
Transfer mechanism, automatic, Sept., 95
Transformer, control circuit (Square D Co.)*, May, 162
Transformer, oil burner ignition (Acme Electric Corp.)*, Aug., 158
Transmissions:
  automatic (Western Mfg. Co.)*, Feb., 146
  gearshift drive (Lima Electric Motor Co.)*, Aug., 151
  torque-converting, July, 117
  two-speed (Eclipse Machine Div.)*, May, 156
  two-speed planetary, Nov., 132
  two-speed for motor bikes, Dec., 146
  variable-speed (Standard Transmission Equipment Co.*, Apr., 190
  variable-speed (Graham Transmissions, Inc.)*, Sept., 148
  variable-speed (Graham Transmissions, Inc.)*, Feb., 145
  variable-speed (Speed Control Corp.)*, Apr., 188
  variable-speed (General Radio Co.)*, Nov., 153
  variable-speed, (Westinghouse Electric Corp.)*, Nov., 156
  variable-speed (Graham Transmissions Inc.)*, Dec., 162
  variable-speed, control (Reeves Pulley Co.)*, Oct., 135
  variable-speed control by ball shape roller bodies*, Sept., 166
  variable-speed, right-angle (Ohio Gear Co.)*, Nov., 152
Transmitter, pneumatic pressure, Apr., 113
Transmitter, temperature (Taylor Instrument Co.)*, July, 144
Tubes:
  cemented carbide (Kennametal Inc.)*, Aug., 155
  electrical-insulating, plastic (Extruders Inc.)*, Mar., 159
  fittings, July, 106
  method for forming*, May, 96
  unions, flared (Roylyn Inc.)*, May, 160
Turbine, gas, 200-hp*, Feb., 184
Turbine, gas, locomotive, July, 110
Turbine, gas, possibilities for automotive power*, July, 68
Turntable motor, dual-speed*, Feb., 136
Tying mechanism, July, 74
Typewriter console produces any desired sound effects*, Oct., 92
Typewriter, world's smallest, Jan., 103

U

Union connection, rotary (Perfecting Service Co.)*, June, 163
Universal joint (Lovejoy Flexible Coupling Co.)*, May, 164
Unpacker for bottle and jar unloading, June, 148

V

Valves:
  air and hydraulic (C. B. Hunt & Son Inc.)*, Sept., 145
  air controlled (Logansport Machine Co.)*, Sept., 147
  air dumping (Ross Operating Valve Co.)*, June, 170
  air-hose (Paul Valve Corp.)*, Apr., 188
  air-solenoid (Valvair Corp.)*, Aug., 152
  air-solenoid (Valvair Corp.)*, Sept., 149
  air-solenoid (Viking Products Co. Inc.)*, Apr., 190
  air-solenoid (Mechanical Air Controls Inc.)*, Nov., 157
  air-solenoid control (Bellows Co.)*, June, 161
  air-solenoid, controlled by oscillating pilot, Aug., 124
  air-water operating (Leslie Co.)*, Aug., 153
  ball type (Klipfel Mfg. Co.)*, June, 166
  check and needle (Pneu-Trol Devices Inc.)*, Oct., 136
  check, cone (Parker Appliance Co.)*, Feb., 148
  check, high-pressure (Hoke Inc.)*, Mar., 162
  check, hydro-pneumatic (Kohler Co.)*, Jan., 150
  control (Annin Co.)*, Aug., 155
  control, foot-operated (Modernair Corp.)*, June, 163
  control, pneumatic (Modernair Corp.)*, Feb., 156
  control, pneumatic (Airmatic Valve, Inc.)*, Jan., 148
  control, pneumatic, (Hanna Engineering Works)*, Nov., 160
  control, pneumatic, disk (Hannifin Corp.)*, Dec., 161
  diaphragm, high volume (C. A. Norgren Co.)*, Nov., 158
  double-piloted (C. B. Hunt & Son Inc.)*, Oct., 137
  flow-control (Airmatic Valve)*, Mar., 166
  gate, cast-steel (Crane Co.)*, Mar., 158
  gate, stainless steel (The Cooper Alloy Foundry Co.)*, Aug., 158
  globe, plug type (Jenkins Bros.)*, Feb., 145
  high-pressure check (Kohler Co.)*, Aug., 154
  high-pressure hydraulic, sealing of*, Sept., 166
  hydraulic, automatic*, Jan., 170
  hydraulic, control*, Sept., 106
  hydraulic, control (Hydraulic Equipment Co.)*, Sept., 148
  hydraulic, for divided flow*, Sept., 164
  hydraulic, relief (Gerotor May Corp.)*, Jan., 158
  magnetic, for locking brakes at desired pressure*, Sept., 166
  manual control (Saval Inc.)*, June, 165
  oil, pilot (Gerotor May Corp.)*, June, 168
  packless air control (Logansport Machine Co.)*, June, 160
  packless diaphragm (Crane Co.)*, May, 155
  packless globe*, June, 155
  pilot (Hanna Engineering Works)*, Oct., 140
  pneumatic, hand-operated (Numatics)*, Feb., 146
  pneumatic relay, Apr., 109
  pneumatic, three-way (Mead Specialties Co.)*, Nov., 152
  process control, Jan., 129
  quick-exhaust (Airmatic Valve Inc.)*, Feb., 146
  solenoid (Carma Mfg. Co.)*, July, 143
  solenoid (Crescent Valve Co.)*, Dec., 164
  solenoid, high-pressure (Waterman Engineering Co.)*, Mar., 159
  velocity limiting (Pneu-Trol Devices Inc.)*, July, 144
Variable-pitch typewriter rack for even right hand margin*, July, 82
Variable-stroke mechanism*, May, 144
Vessels, pressure, effect of code on design, Sept., 105
Vibration absorbers, design of, Nov., 142
Vibration analyzer (Aircraft Electronics Assoc. Inc.)*, June, 174
Vibration damper (Connecticut Hard Rubber Co.)*, July, 143
Vibration eleminator, torsional*, Feb., 168
Vibration meter (Calidyne Co.)*, July, 152
Vibration mount (Finn & Co.)*, Nov., 160
Vibration mount, all-metal (Robinson Aviation Inc.)*, Feb., 156
Vibration mount, heavy-duty (Finn & Co.)*, Feb., 152
Vibration mount material (Korfund Co.)*, Mar., 157
Vibration pickup (Consolidated Engineering Corp.)*, Jan., 160
Vibration testing apparatus, July, 113
Vibrator, armature, operates portable sprayer*, Aug., 147
Vibrator, electric (Globe Industries Inc.)*, Sept., 151
Vibrator, pneumatic (Cleveland Vibrator Co.)*, July, 140
Vibrograph, Oct., 105
Voltage regulator, automatic (The Superior Electric Co.)*, Sept., 152
Voltage regulator, static generator (Vickers Electric Div.)*, Aug., 152
Voltage tester (Square D Co.)*, Apr., 200
Voltmeter, portable (Pyramid Instrument Co.)*, Sept., 158
Voltmeter, vacuum tube (General Electric Co.)*, Aug., 156

W

Washer, automatic, design features of, Oct., 133
Washer, bouncing basket, discussion of, Feb., 77
Washer, sealing (Franklin C. Wolfe Co.)*, May, 162
Wear measurement*, May, 84
Weaving machine, Sulzer, redesign of, Jan., 79
Welding:
  aluminum, cold, Jan., 180
  arc, of chrome-nickel stainless steel, aluminum bronzes*, Nov., 88
  design factors, June, 135
  electrodes, steel, selection of (Data Sheet), June, 151
  general considerations, May, 119
  projection bosses (Ohio Nut & Bolt Co.)*, Apr., 188
  seam, for compressor housing*, Jan., 144
  similar steels, redesign for, Nov., 166
Weld-nut (National Screw & Mfg. Co. and Lamson & Sessions)*, July, 141
Weld-nut, locking (Grip Nut Co.)*, Apr., 190
Weld-nuts and screws (Ohio Nut & Bolt Co.)*, July, 140
Wheels:
  assemblies (Kelsey-Hayes Wheel Co.)*, Sept., 145
  cast-aluminum, industrial (Pikes Peak Aluminum Foundry)*, Mar., 166
  disk, industrial (Geneva Metal Wheel Co.)*, Sept., 152
  industrial (Bassick Co.)*, Nov., 157
  pneumatic, industrial (Geneva Metal Wheel Co.)*, Apr., 196
  semipneumatic or hard (Paramount Engineering)*, Mar., 160
  small, industrial (Geneva Metal Wheel Co.)*, July, 141
Whiteprinting machine (C. F. Pease Co.)*, Dec., 170
Wire, drawn, nickel-alloy (Kemet Laboratories)*, Feb., 146
Wire harnesses, armored (Interstate Mfg. Co.)*, Jan., 156
Wire sleeving, glass fiber (Bently, Harris Mfg. Co.)*, Sept., 150
Worm gear, ball bearing*, Apr., 212
Wrench, torque, employs toggle principle*, Aug., 147

Z

Zippers to fasten rubber diaphragms in car coupling*, June, 92

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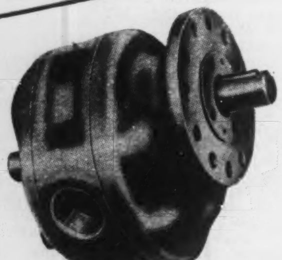

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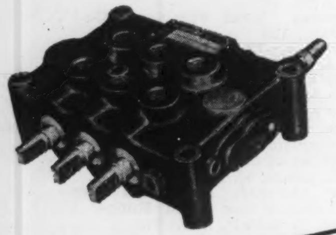

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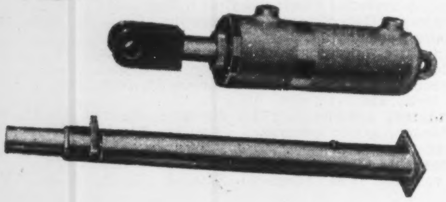

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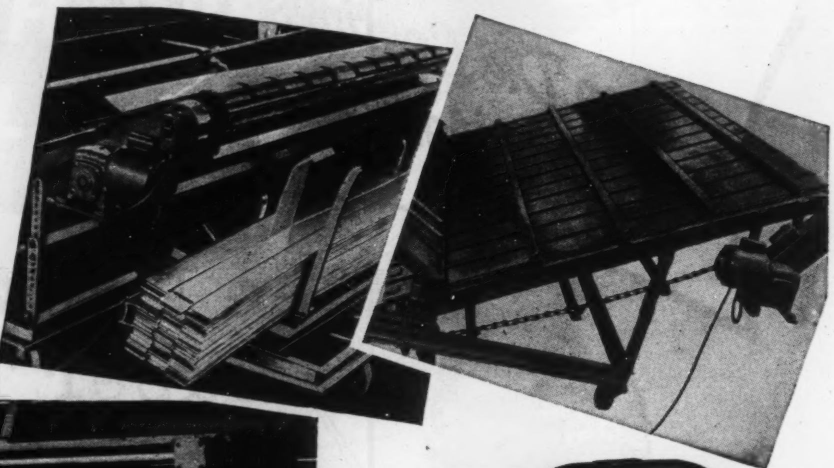
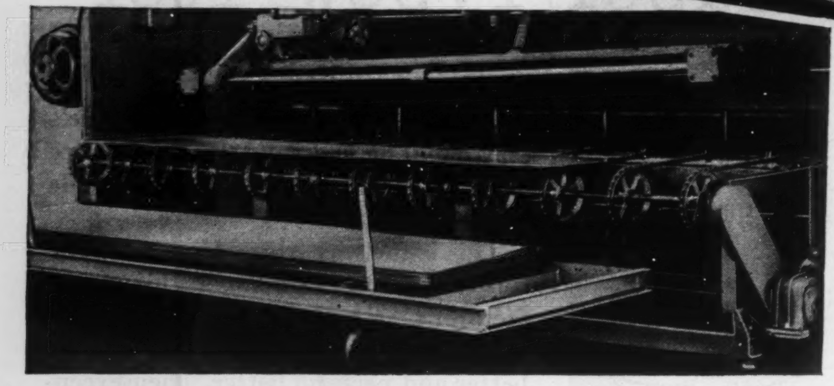
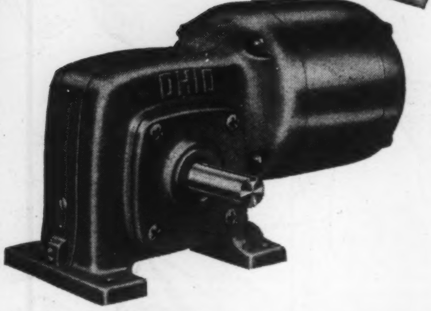






In these Fried sheet and strip handling units, large volume shear operators find these definite, cost-cutting advantages; (1) faster, more accurate shearing by eliminating pile-ups back of the shear; (2) reduction of labor fatigue; (3) a high safety factor.

Of prime importance in these conveyors and stackers is the drive mechanism. It must be smooth, dependable, synchronized to the operating speed of the shears. It must be sturdy and long-lived. It must operate efficiently with a minimum of attention.

In Ohio Gear Motorized Reducers, Fried engineers found the required factors. Ohio Gear Motorized Reducers are sturdy and efficient. The balance between motor and reducer capacity is carefully maintained. They are long-lived. They require a minimum of attention. And, because they are stock reducers, instead of "specials", they afford substantial savings in production costs.

Get the full facts on Ohio Stock Gears and Reducers for your own production needs. Get in touch with our nearest distributor or write us today.

ESTABLISHED 1915

OHIO GEARS

DISTRIBUTORS AND REPRESENTATIVES

*Akron, Ohio
Hardware & Supply Co.
*Baltimore, Md.
L. A. Benson Co., Inc.
Buffalo, N. Y.
F. E. Allen
*Buffalo, N. Y.
S. H. Pooley Belting Co.
Chicago 7, Illinois
Schrade-Batterson Co.
Dayton, Ohio
E. C. Hawk
*Detroit 6, Michigan
Eynon-Dakin Co.
Detroit 26, Mich.
George P. Coulter
*Erie, Pa.
Crossley Co.
*Findlay, Ohio
Bearing & Transmission Co.
*Grand Rapids, Mich.
F. Raniville Co.
*Hagerstown, Md.
Hagerstown Equipment Co.
Indianapolis, Indiana
A. R. Young
*Kansas City, North, Mo.
Sesco Engineering & Supply Corp.
*Los Angeles, Calif.
J. W. Minder Chain & Gear Co.
Louisville 2, Ky.
Alfred Halliday
*Memphis 2, Tenn.
Memphis Bearing & Supply Co.
*Miami 9, Fla.
General Equipment & Supply, Inc.
*Minneapolis, Minn.
Industrial Supply Co.
*Muskegon, Mich.
Lake Shore Machinery & Supply Co.
*New Orleans 12, La.
R. J. Tricon Co.
*New Orleans 9, La.
Woodward Wight & Co.
*New York 12, N. Y.
Atlantic Gear Works
*New York 13, N. Y.
Patron Transmission Co., Inc.
Pawtucket, Rhode Island
George G. Pragst
*Philadelphia 6, Pa.
Robert L. Latimer Co.
*Philadelphia 6, Pa.
Rothman Belting & Equipment Co.
*Pittsburgh, Pa.
Standard Machinists Supply Co.
*Portland, Oregon
J. W. Minder Chain & Gear Co.
*Rochester 4, N. Y.
H. M. Cross and Sons
*San Francisco, Calif.
The Adam Hill Co.
*St. Louis, Mo.
The Essmueller Co.
*Syracuse, N. Y.
U. and S., Inc.
*Toledo, Ohio
The Bearing & Transmission Co.

IN CANADA
*Montreal, Quebec, Canada
John Braidwood & Sons, Ltd.

**Stocks Carried.*

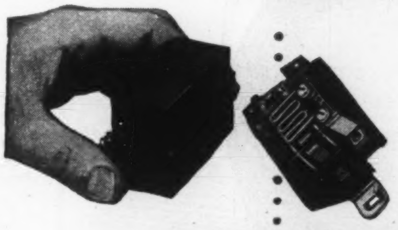
THE OHIO GEAR COMPANY

1338 EAST 179th STREET • CLEVELAND 10, OHIO

INCREASED VALUE

no increase in price

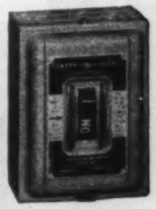
manual motor starters...

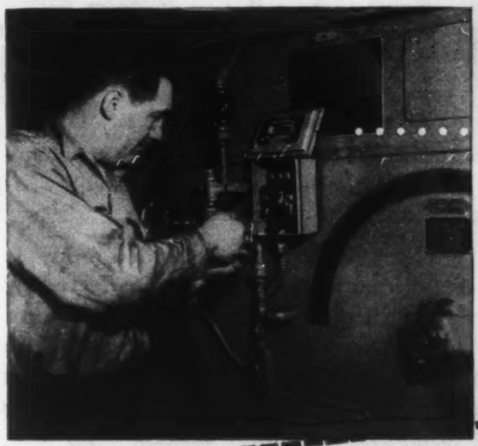


.... feature quick, easy installation; positive overload protection with long-life bi-metallic relays; easy wiring and servicing because terminals are wired from the front. Application—fractional and integral motors up to 7½ horsepower.

The CR1061 controls a handkerchief ironer in a modern laundry.

The CR1062 is easy to mount and wire. Used here on a coolant pump.





Roomy, attractive case can be mounted on or beside the machine. Sturdy switch mechanism resists vibration. New push-button as well as toggle-type forms now available for integral motor starting. All forms—watertight, dust-tight, and explosion-proof—available in both lines. Write now for more information. *Remember, these new starters have all the features you've been wanting at no increase in price.*

General Electric Company
Apparatus Dept., Sec. G730-9
Schenectady 5, N. Y.

Please send me—
Bulletin GEA-2234E on CR1061 Fractional-hp Motor Starters..........................
Bulletin GEA-1522F on CR1062 Integral Motor Starters ....

NAME ....
COMPANY..........................
ADDRESS..........................
....

GENERAL ELECTRIC

yes... an oil seal that's tailor-made to *resist* corrosion

● If corrosive conditions are shortening the life of your oil seals, the Johns-Manville Clipper Seal should provide a practical solution to your problem.

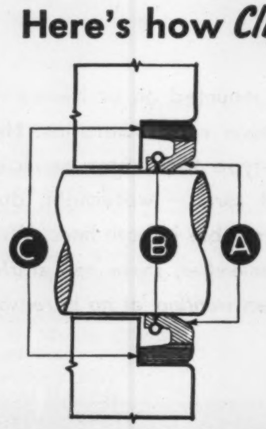
Here's why: The Clipper Seal's molded body is entirely non-metallic and is, therefore, unaffected by most forms of corrosion. To meet special conditions, the garter spring which holds the lip in contact with the shaft can be furnished in various corrosion-resistant metals . . . *or Clipper Seals of special design that do not require garter springs may be used.*

The one-piece, concentric molded design of Clipper Seals also assures a number of other advantages. The hard, tough outer heel of the Clipper Seal is resilient enough to conform even to a slightly out-of-round cavity. And the soft, pliable inner lip always maintains a light, but positive sealing pressure on the shaft, with minimum wear on the seal.

Clipper Seals are quick and easy to install, may be had in split or endless types, are available in sizes from ¼″ I.D. up to 66″ O.D. If you have a special sealing requirement, or wish to consult about a special design problem, write Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE
JM
PRODUCTS

Here's how *Clipper Seal* works:



The flexible lip (A) is held in light but firm contact with the shaft by means of the garter spring (B). Pressure on shaft is carefully pre-determined to minimize wear, yet effectively seal against leakage. The rigid heel (C) provides a press fit in the cavity, assuring a tight lubricant-retaining seal at this point also.

Johns-Manville ***PACKINGS & GASKETS***

AJAX

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, N. Y.

FLEXIBLE COUPLINGS

Safeguard your direct-connected machines against unavoidable misalignment with the positive, resilient drive of Ajax Flexible Couplings.

Write for Data Book.

why CRANE DIAPHRAGM VALVE DESIGN *is Superior*

LONGER DIAPHRAGM SERVICE LIFE—Diaphragm is not subject to cutting, crushing, and rapid wear since it is used *only* to seal the bonnet; not for seating purposes.

POSITIVE SHUT-OFF in case of diaphragm failure. *This is an exclusive Crane safety feature.*

ACCURATE SEATING—Circular flat face disc with resilient neoprene seating surface gives tight closure—independently of diaphragm—on all fluids.

GREATER FLOW CAPACITY—Y-pattern body design gives closer approximation to straight-line flow, reduces resistance and pressure drop.

EASIER OPERATION—Less torque— fewer turns—needed to operate valves—especially in larger sizes.

PLAIN IRON OR NEOPRENE-LINED—Unlined valves will handle all common services. Neoprene-lined valves are recommended for fluids corrosive to iron but non-active chemically upon neoprene.

WORKING PRESSURES:

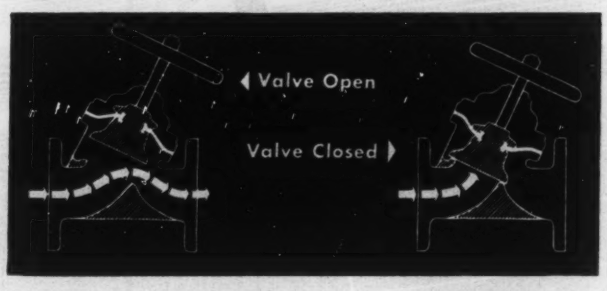
150 Pounds
water, oil, air, or gas;
½ through 4-in. sizes

125 Pounds
water, oil, air, or gas;
6-in. size only

180 Deg. F.
max. temp.; all sizes

HOW IT WORKS

The Crane diaphragm performs one job *only*—sealing the bonnet against line fluids. The seating member is a separate circular flat face disc, firmly attached to the stem and joined to the diaphragm with a special leakproof connection. This independent seating arrangement permits positive shut-off of flow, even in case of diaphragm failure.



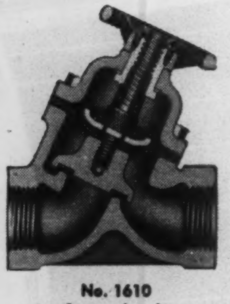
SEND FOR THIS NEW CIRCULAR

Contains complete information about these outstanding valves—including all essential specification data, service recommendations, and list prices. Ask your Crane Representative for your copy, or WRITE FOR CIRCULAR AD-1761. No obligation.

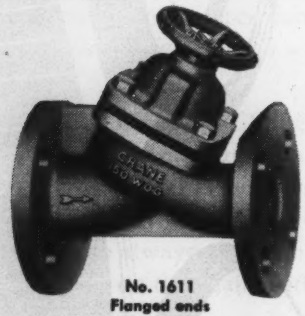
diaphragm valves
CRANE

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

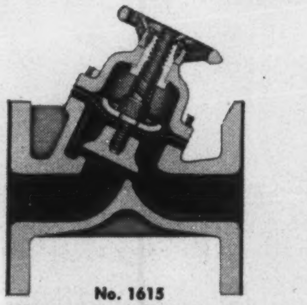
NOW AVAILABLE IN SIZES UP TO 6-INCHES



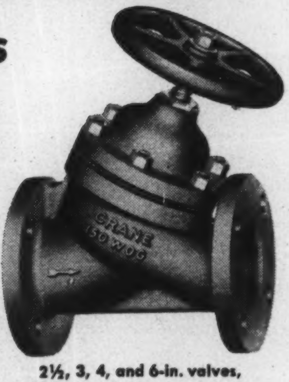
No. 1610
Screwed ends
½ to 2-in.



No. 1611
Flanged ends
½ to 6-in.



No. 1615
Neoprene-lined, Flanged ends
½ to 6-in.



2½, 3, 4, and 6-in. valves,
Plain iron or Neoprene-lined,
have rising, turning stem

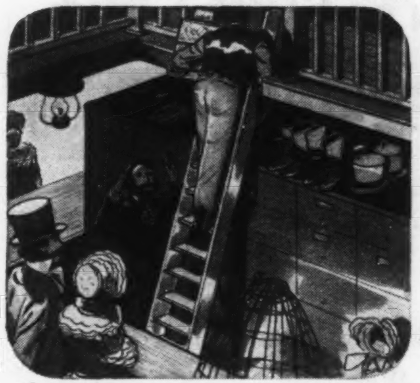
EVERYTHING FROM . . .

VALVES
FITTINGS
PIPE

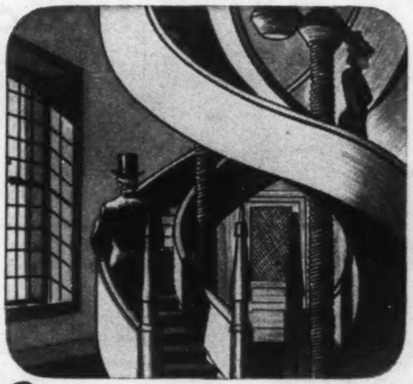
CRANE

PLUMBING
AND
HEATING

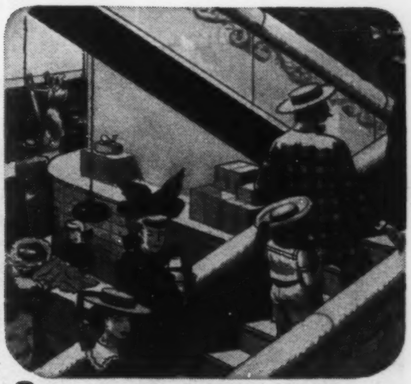
FOR EVERY PIPING SYSTEM



1 **1800**—For centuries, steps were man's main means of going up. First came the ladder; later, crude steps formed stairways. Even so, man still had to ascend a step at a time under his own power.

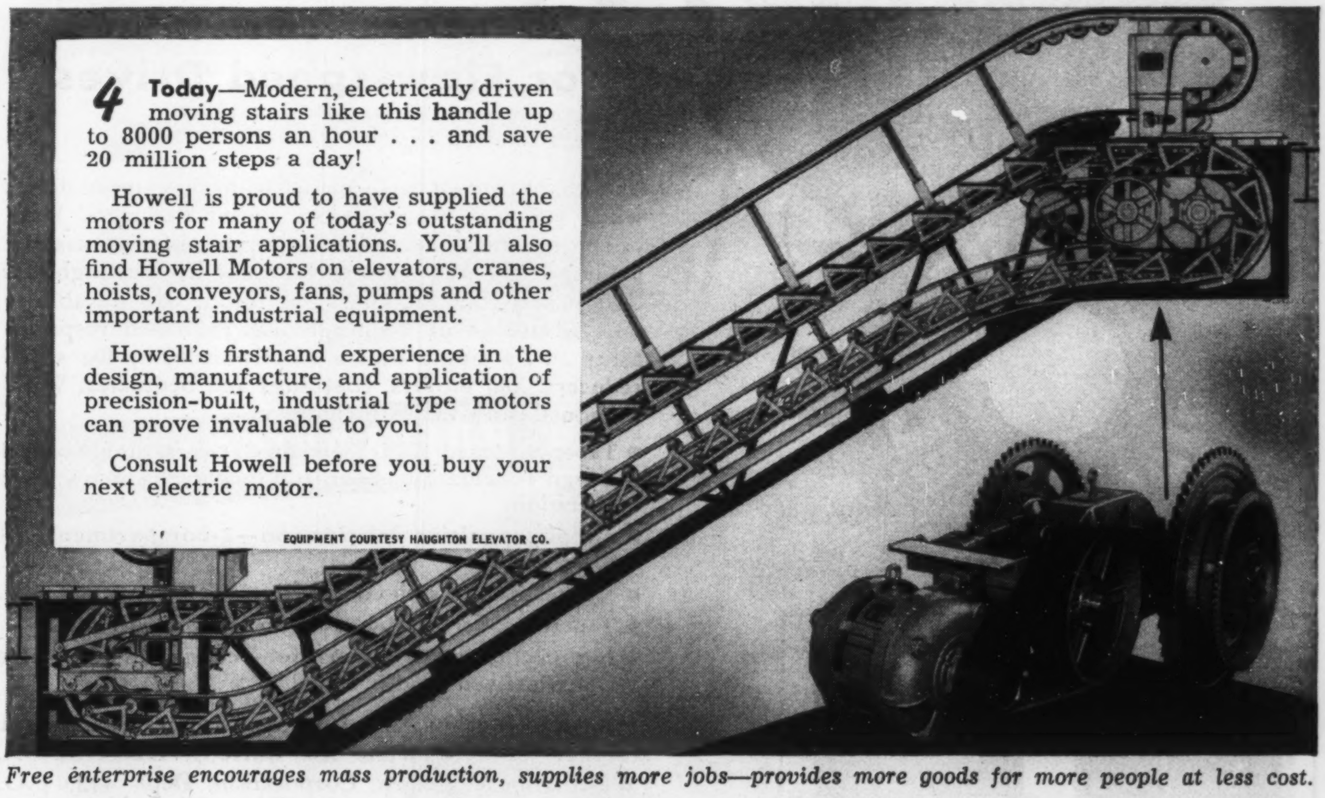


2 **1875**—Stairways took all forms—straight, spiral, plain and ornate. Then, one Samuel Gray patented an "elevator and moving stairway." Though impractical, his idea set others to work.



3 **1901**—The forerunner of today's moving stairs was installed in a New York store. By 1915, Howell "Red Band" Electric Motors arrived. Soon, these rugged motors were widely applied.

SAVED...20 MILLION STEPS A DAY!



4 **Today**—Modern, electrically driven moving stairs like this handle up to 8000 persons an hour . . . and save 20 million steps a day!

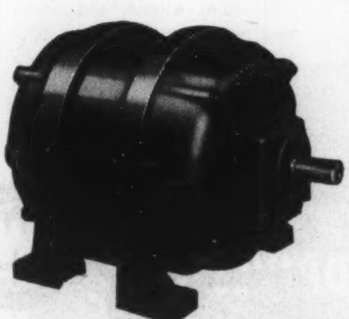
Howell is proud to have supplied the motors for many of today's outstanding moving stair applications. You'll also find Howell Motors on elevators, cranes, hoists, conveyors, fans, pumps and other important industrial equipment.

Howell's firsthand experience in the design, manufacture, and application of precision-built, industrial type motors can prove invaluable to you.

Consult Howell before you buy your next electric motor.

EQUIPMENT COURTESY HAUGHTON ELEVATOR CO.

Free enterprise encourages mass production, supplies more jobs—provides more goods for more people at less cost.



Elevator Type Motor

HOWELL MOTORS

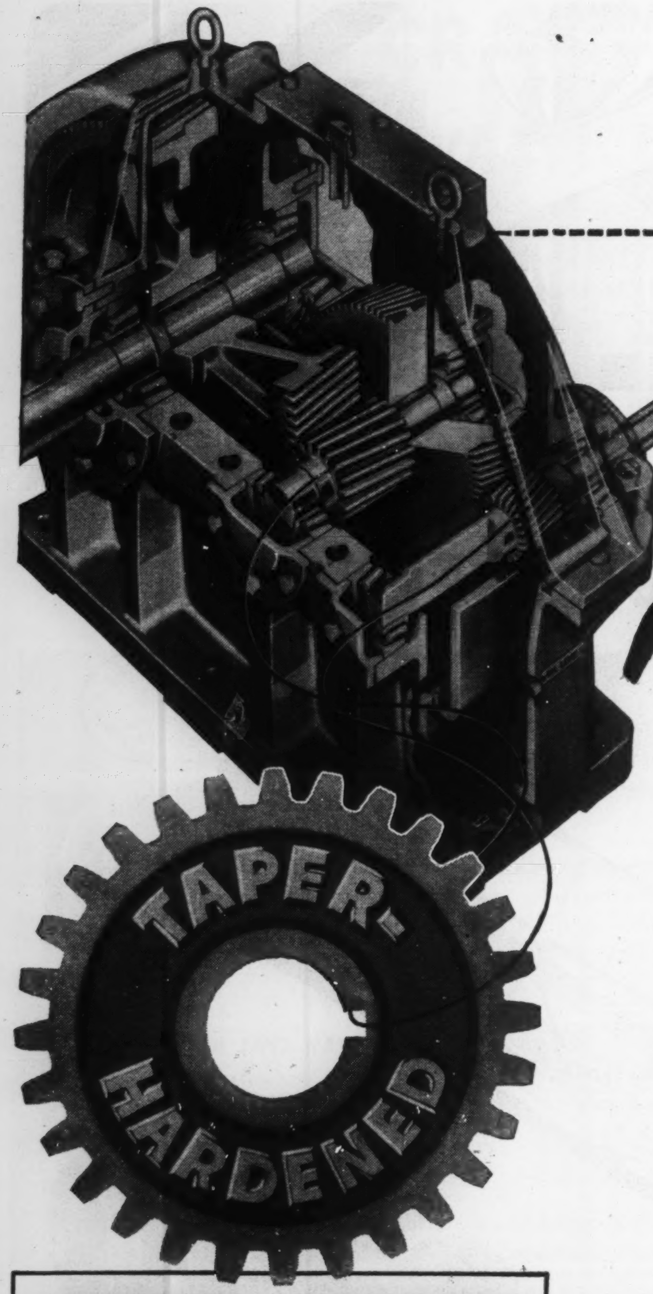
HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

Precision-built Industrial Motors Since 1915

HOWELL
Red Band
MOTORS

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



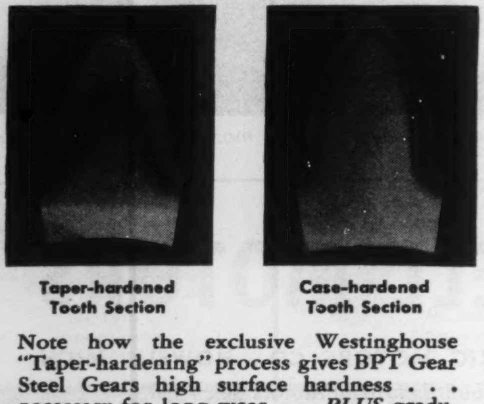
Top Performance

for Slow-speed Drives

You get maximum performance from slow-speed drives when you use Westinghouse Speed Reducers. High operating efficiency and long service life are assured by important *plus* features inherent in Westinghouse design and construction. In addition, you are able to take advantage of Westinghouse undivided responsibility . . . a single source of responsibility for speed reducers, *and* motors, couplings and bedplates. Westinghouse extra values include:

- Taper-hardened BPT Gear Steel Gears, single-helical design . . . for maximum load-carrying capacity, quiet operation.
- Simple, positive lubrication—2-compartment oil reservoir.
- Rugged case of split construction, for easy accessibility.
- Tapered roller bearings—minimum friction loss.
- Nationwide service organization—competent help where and when you need it.

Call your nearby Westinghouse representative for further data, or write for Bulletin DB-3700-SR, Westinghouse Electric Corporation, Dept. 412, P.O. Box 868, Pittsburgh 30, Pennsylvania. J-07283



Taper-hardened Tooth Section **Case-hardened Tooth Section**

Note how the exclusive Westinghouse "Taper-hardening" process gives BPT Gear Steel Gears high surface hardness . . . necessary for long wear . . . *PLUS* graduated hardness toward the root of the tooth . . . necessary for toughness.

Westinghouse

GEARED DRIVES

The SKF SUA unit pillow block

its DESCRIPTION

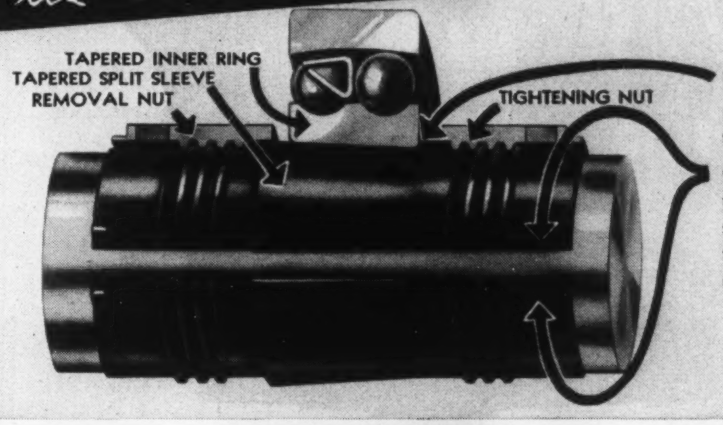
To maintain a *tight fit* between bearing and shaft, you need an SKF SUA unit pillow block.

It's completely assembled, lubricated and ready for immediate use. Available in "free" and "held" types . . . and in shaft sizes from 1 7/16" to 2 7/16".

Its SKF-exclusive Align-O-Seals prevent lubricant leakage and dirt intrusion. No exposed bearing . . . no lock screws to raise troublesome burrs on the shaft . . . for the nut is locked to the sleeve. Even though the shaft vibrates, the concentric grip will not loosen.

Designated as type SUA with ball bearings—and type SUAR with spherical roller bearings.

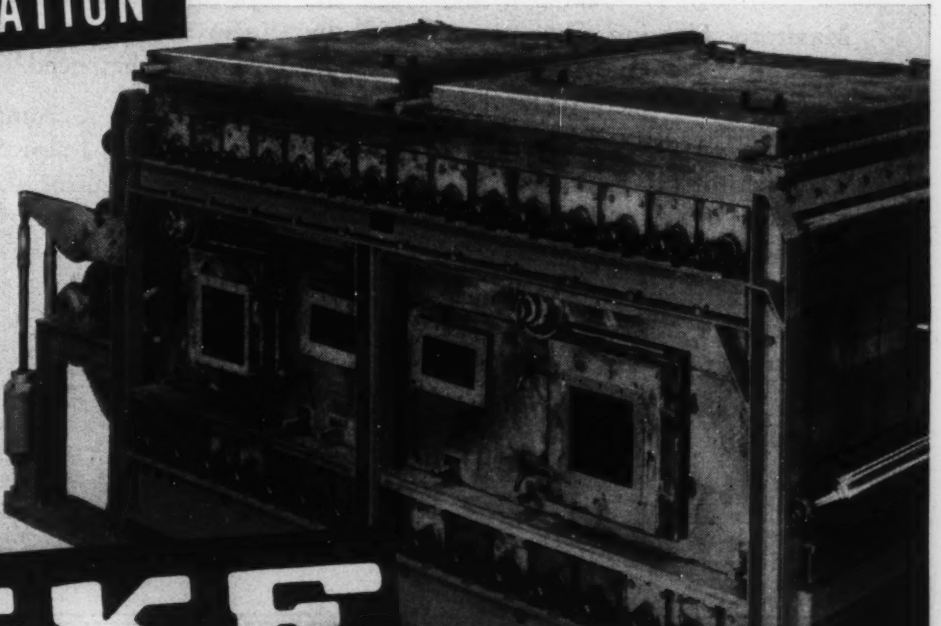
its CONSTRUCTION



TIGHT FIT results when the tightening nut pushes the tapered inner ring over the tapered split sleeve.

CONCENTRIC GRIP is firm and positive—as the split sleeve contracts and wraps around the shaft. Removal is accomplished by reversing the process—with tightening nut loosened, removal nut pushes inner ring off the sleeve.

its APPLICATION



THE GREENVILLE STEEL AND FOUNDRY COMPANY of Greenville, S. C., specified SKF SUA units and built a "tight fit between bearings and shafts" into this DuPont Steamer for piece goods drying.

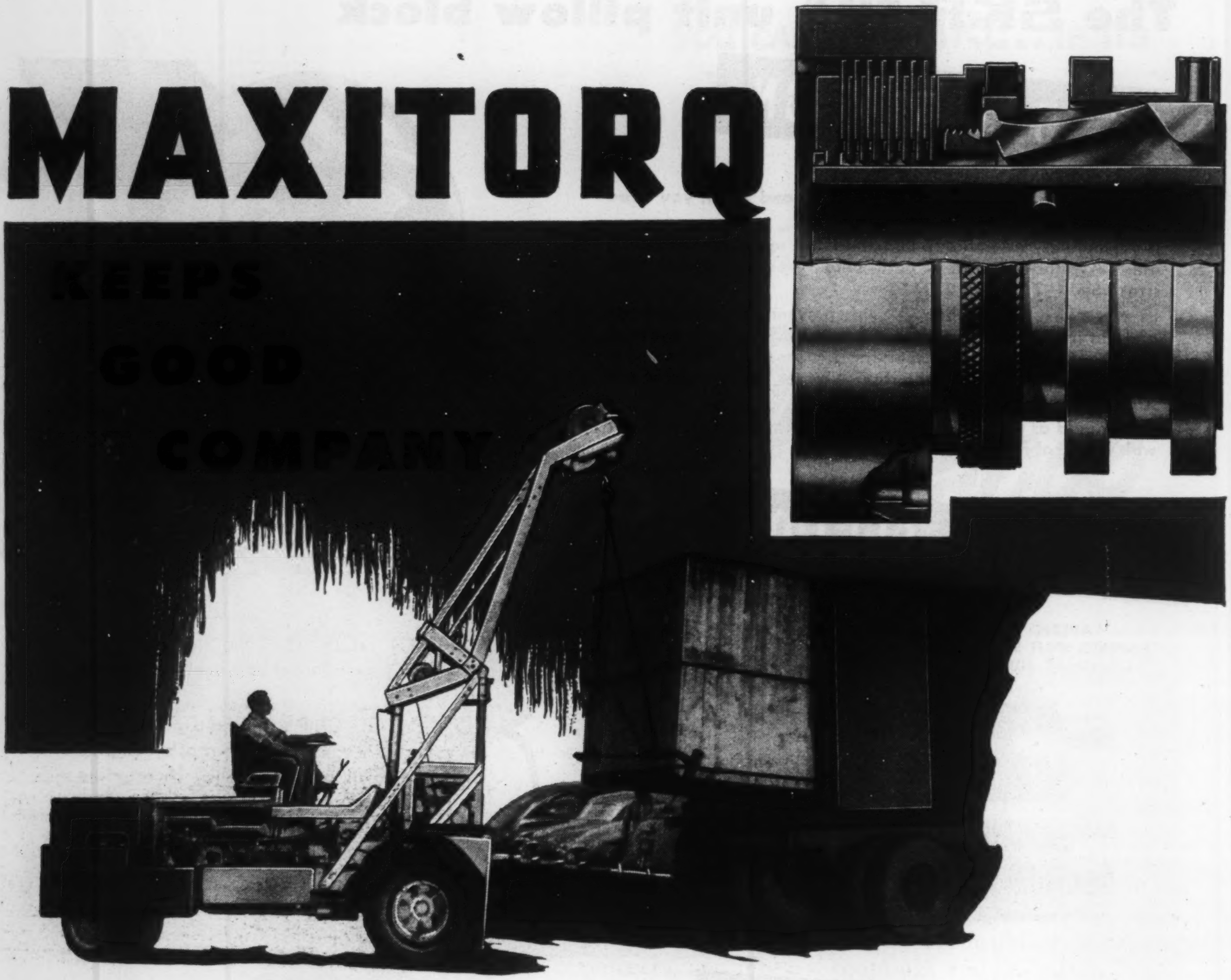
64 SKF SUA 107 unit pillow blocks help maintain long-range dependability on this unit which operates at 150 yards per minute maximum. Our engineers can show you why the SKF SUA unit pillow block belongs in your specifications. Write today.

6600

SKF

INDUSTRIES INC., PHILADELPHIA 32, PA.

MAXITORQ



Shown above are the Maxitorq Floating Disc Clutch and the modern Steve-Krane Stevadore 5 ton capacity Crane, manufactured by the Silent Hoist & Crane Co., Brooklyn, N. Y.

The Maxitorq is inside the winch and transmits the power for Hoisting and Lowering for the load line.

Here's a further instance of the fast growing adoption of Maxitorq Clutches by nationally known manufacturers.

Other product or machine designers, manufacturers of machine tools or machinery may also find that Maxitorq has the "extra" features they need.

For instance . . . compact, streamline design; patented Separator Springs that keep discs apart in neutral . . . no drag, abrasion or heating. No tools needed for assembly, adjustment, take-apart. Shipped completely assembled ready to slip onto a shaft. Capacities to 15 H.P. at 100 r.p.m., wet, dry, single or double.

Want to join our "Good Company" family?

Send for Catalog MD12

8CJ49

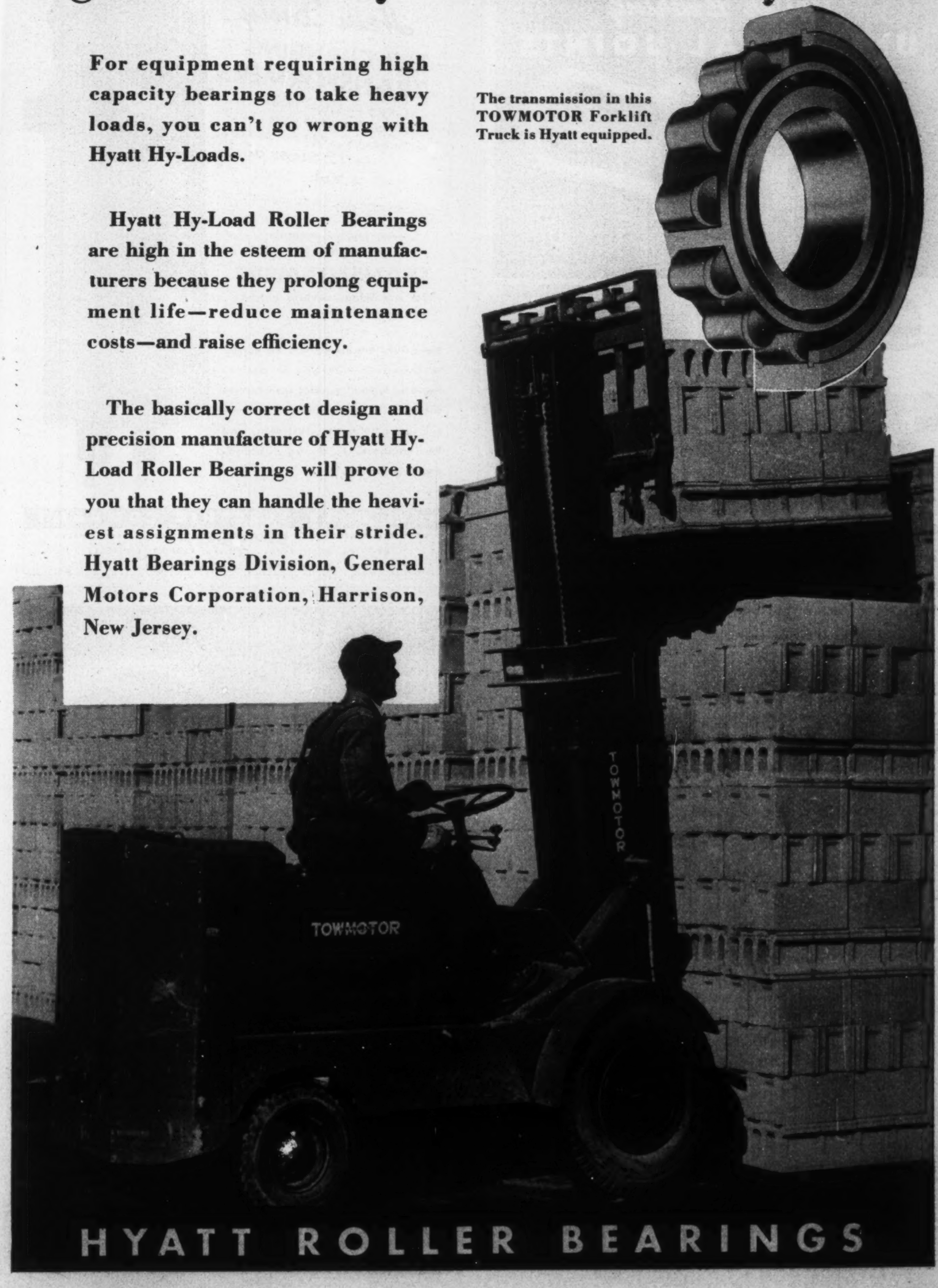
THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT

Higher Efficiency with HYATT Hy-Loads

For equipment requiring high capacity bearings to take heavy loads, you can't go wrong with Hyatt Hy-Loads.

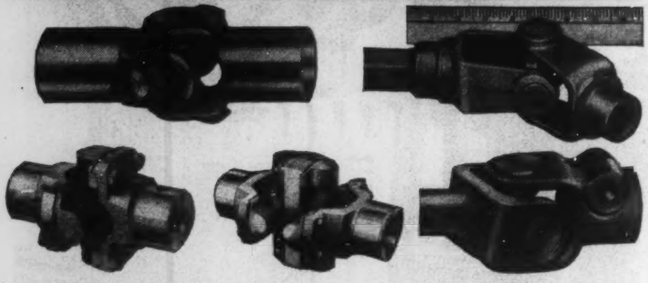
Hyatt Hy-Load Roller Bearings are high in the esteem of manufacturers because they prolong equipment life—reduce maintenance costs—and raise efficiency.

The basically correct design and precision manufacture of Hyatt Hy-Load Roller Bearings will prove to you that they can handle the heaviest assignments in their stride. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.



The transmission in this TOWMOTOR Forklift Truck is Hyatt equipped.

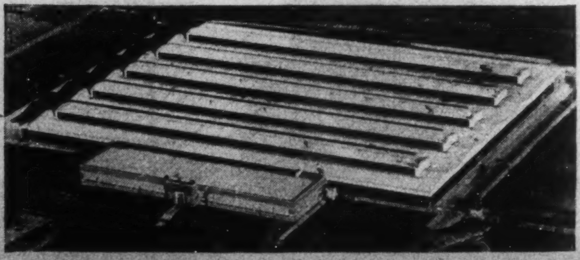
MECHANICS
Roller Bearing
UNIVERSAL JOINTS



-with 40 Years Experience

Back of every MECHANICS Roller Bearing UNIVERSAL JOINTS application is over 40 years of experience designing, building, applying and servicing universal joints—for millions of cars, trucks, tractors, farm implements, road machines and industrial equipment. A complete engineering service and two huge factories, using the most modern and efficient equipment, are available to help improve the propeller shaft units in *your* product. Our new catalog—showing the complete line of MECHANICS Roller Bearing UNIVERSAL JOINTS and PROPELLER SHAFTS—will be sent to manufacturers, upon request.

Two modernly equipped plants efficiently producing universal joints and propeller shafts exclusively.



MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • [illegible] Harrison Ave., Rockford, Ill.

HEVI DUTY ELECTRIC COMPANY

Hevi Duty
TAP CHANGING TRANSFORMERS

5 KVA — Single Phase
Primary 440 Volts
Secondary 440 to 156 Volts
in 72 Steps of 4 Volts Each

— a typical example of special type
TRANSFORMERS
for use where several output voltages are required.

Hevi Duty engineers will be happy to cooperate with you in designing any type of special transformer for specific applications. We have the equipment, the craftsmen, and the engineers to do an outstanding job for you.

HEVI DUTY ELECTRIC COMPANY
HEAT TREATING FURNACES HEVI DUTY ELECTRIC EXCLUSIVELY
DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS
MILWAUKEE 1, WISCONSIN

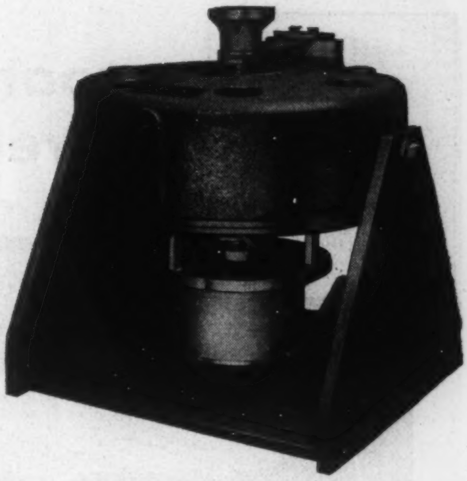
---

dependable performance with
Janette
Blower Wheels
5in. to 12 In.

DISTINCTIVE FEATURES—The soft steel blades are made in pairs, pressed thru slots in the heavy steel back plate, then welded to the plate. The blade tips are pressed thru slots in the inlet disc then bent back against the spring of the steel blades. This ***patented construction*** results in an exceptionally rigid wheel and ***prevents loose blades,*** as no rivets are used in fastening the blades. The heavy cast iron machined hub is riveted to the back plate and will not crack or become loose on the shaft.

JAN-AIR, INC. Manufacturers
RICHMOND - ILLINOIS - U.S.A.

It PAYS to work with an MB Vibration Exciter



You can save time, eliminate tedious calculations, and improve your product with the help of an MB electromagnetic shaker. Note how these benefits add up in the following typical applications—just three of many uses for this quality-control and research "tool."

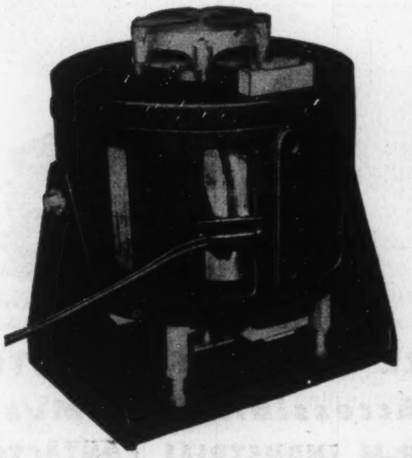
MODEL 5A VIBRATION EXCITER Delivers 5 pounds force from 20 to 1.000 c.p.s., usable to 20,000 c.p.s.

INDEFATIGABLE FATIGUE TESTER—Here is the endurance tester to show up *quickly* those faults which often result in failures under dynamic stresses. Why risk trouble reports? You can shake such parts as axles, brackets, complete assemblies, housings, castings and make improvements *before* full scale production—*before* the remedy becomes costly.

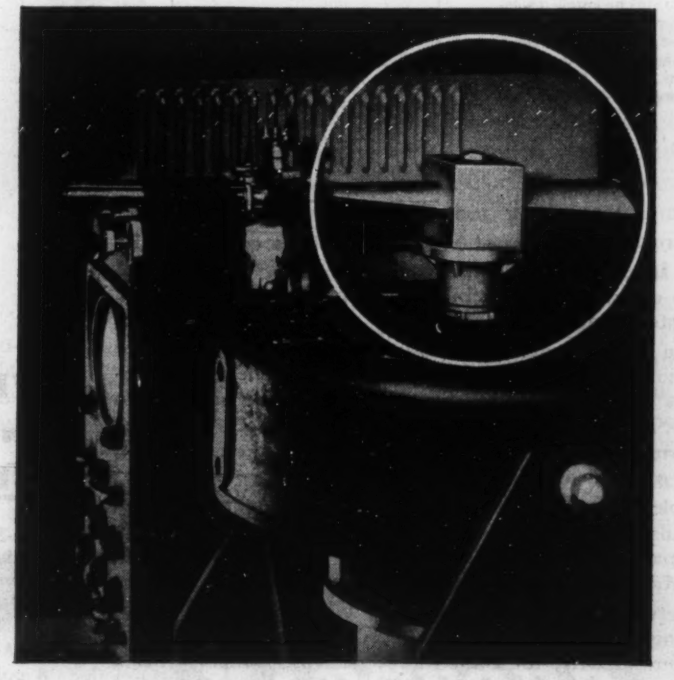
NOISE LOCATER—Operating silently, the MB Exciter reveals sources of noise in equipment of all types. Because you can "scan" a product's operating frequency range, you can put your finger right on resonant trouble areas. Less noise means more customer satisfaction.

SHAKE OUT THE "BUGS"—Electrical and sensitive components can be checked for ability to withstand severe vibratory service conditions. Reproduce the effect of years of vibration on your product within *hours!*

You'll find MB Vibration Exciters at work for many leading companies recognized for the quality of their engineering. Would you like to know how to apply one to your *own* problems? An MB engineer will be glad to show you—without obligation.



MODEL S3 VIBRATION EXCITER Delivers controlled force up to 200 pounds, in frequency range of 3 to 500 c.p.s.



Testing of small turbine blades (encircled) mounted on an MB Model C-1 Exciter which delivers 25 pounds force in range of 4 to 500 c.p.s. (and higher). Using stroboscopic lighting, resonances and deflections are studied *visually*—and any need for corrections determined quickly. A stronger, stiffer blade is sure to result.

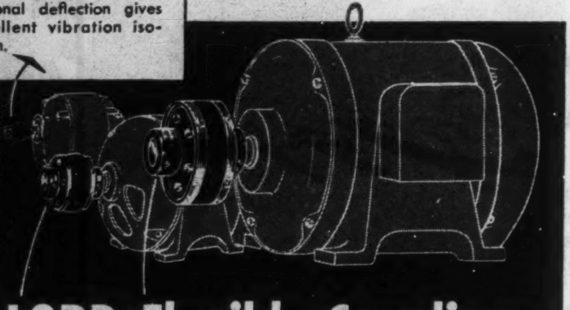
DO YOU HAVE OUR NEW BULLETIN ON FILE?

It contains helpful design data on vibration control, plus more information on the line of MB Exciters. Write for your copy today. Ask for bulletin No. 410-G8.

THE MB MANUFACTURING COMPANY, Inc.
1060 State St., New Haven 11, Conn.

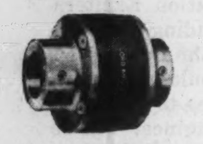
1/50 TO 1 H.P. @ 1750 R.P.M.
Compact, one-piece construction. Convenient for small equipment. 15° rated torsional deflection gives excellent vibration isolation.

smoother power . . .

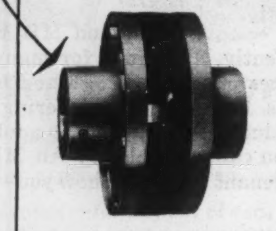


LORD Flexible Couplings

1/50 to 100 h.p.



2 TO 15 H.P. @ 1750 R.P.M.
Simple 3-piece construction. May be installed without moving equipment. No need to dismantle entire assembly. Low assembly costs. Highly flexible yet strong. 15° deflection.



20 TO 100 H.P. @ 1750 R.P.M.
The answer to destructive torsional vibration from high power drive systems. Removable flexing joints enable replacement without moving equipment. 3° deflection.

The development of Lord M.H.P. Couplings completes the line of Lord Flexible Couplings from 1/50 to 100 h.p. and greatly extends the possibilities for product improvement and customer appeal.

Large torsional deflection assures an even flow of power from motor to driven equipment. The Neoprene flexing element is oil resistant . . . there are no bearing surfaces to chafe . . . no lubrication is required. Lord M.H.P. Couplings are permanently quiet . . . they are unaffected by sand, emery, or other abrasives.

Simple construction and a high degree of accommodation to angular and parallel misalignment reduce assembly costs. It will pay you to investigate the advantages of incorporating Lord M.H.P. Couplings in your product design.

Bulletin 201 describes the complete line of Lord Flexible Couplings. See our bulletin in Sweet's 1949 File for Product Designers or write for Bulletin 900 showing Lord Vibration Control Mountings and other Bonded Rubber Products.

LORD MANUFACTURING COMPANY • ERIE, PA.
Canadian Representative: Railway & Power Engineering Corp. Ltd.

LORD Vibration Control Systems

SPECIFY
alliance motors
for
Small Load Jobs!

Fans	Toys
Business Machines	Vending Machines
Controls	Radio & television tuning
Heating Appliances	Other appliances
Turntables	

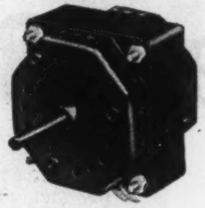
Mass production of small motors for *mass* markets at low cost—that's the job at Alliance!

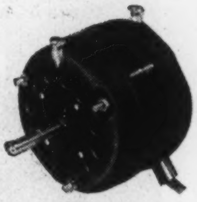
Alliance motors rated from less than 1/400 h.p. on up to 1/25 h.p. are made semi-open, and fully enclosed. Some are uni-directional and others are reversible. Motors are designed for both continuous and intermittent duty loads. Covering a wide range of standard AC voltages and frequencies, Alliance offers motors of varied types with operating characteristics to fit the specific needs of small loads. Individual changes in design are available where quantity warrants.

Check these advantages!
- Low operating cost
- Low induced hum
- Low magnetic field
- Low first cost
- Cool running—quiet
- Flexible power range
- Slower controlled speeds
- Long life

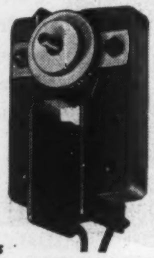
Write for catalog and specifications

MODEL B
4-pole shaded pole motor. Approx. 1/30 h.p. 1550 r.p.m.



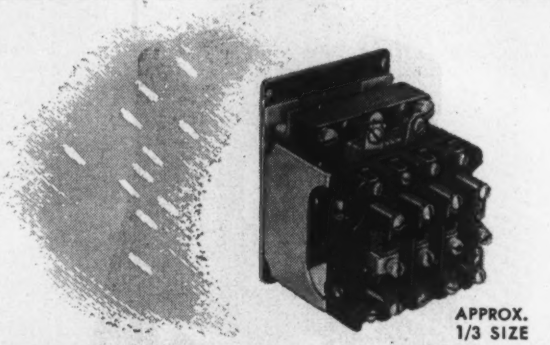


MODEL A
6-pole shaded pole motor. Approx. 1/30 h.p. 500 to 1050 r.p.m.



MODEL MS
2-pole shaded pole motor — full load h.p. .0021. Full load 2800 r.p.m.

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO
Export Department: 401 Broadway, New York 13, N. Y., U. S. A.



APPROX. 1/3 SIZE

WHERE SPACE IS A FACTOR
and Accessibility a Must—
USE R-B-M INDUSTRIAL CONTACTORS

R-B-M Industrial Contactors, with interchangeable normally open and normally closed contacts, can be mounted in minimum space without sacrificing accessibility. You will also find that the initial low cost of R-B-M, plus long and dependable performance, will save you money.

Available in 10 and 15 ampere sizes, 600 volt A.C., 2 to 8 pole non-reversing—2 to 4 pole reversing. Open and enclosed types. Write for Bulletin and Price List on your company letterhead.

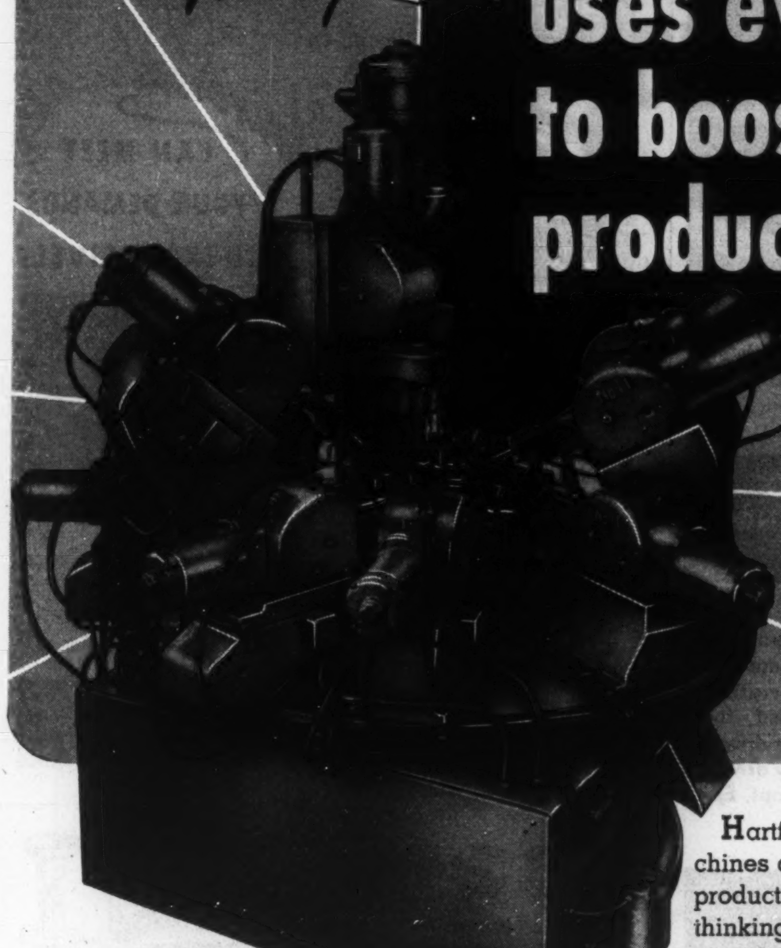
Dept. H-12 R-B-M DIVISION OF ESSEX WIRE CORP.
Logansport, Indiana

RBM
MANUAL AND MAGNETIC ELECTRIC CONTROLS
FOR AUTOMOTIVE INDUSTRIAL COMMUNICATION AND ELECTRONIC USE

"Packaged Engineering" uses every angle... to boost production

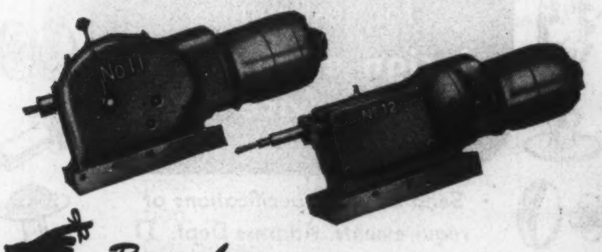
with
Hartford Special

AUTOMATIC DRILLING & TAPPING MACHINES



This machine drills 11 holes, counterbores 3, and taps 5 with nine drilling units and two tapping units. One drilling unit uses a four spindle attachable head, and one tapping unit has an eight spindle attachable head. The eight station dial indexing mechanism is motor driven, and the entire machine is electrically interlocked.

Hartford Special Drilling and Tapping Machines are designed to take the guesswork out of production. Packaged Engineering includes all the thinking and building necessary to put a self-contained unit in your hands. Sequence of operations and overall design are calculated to reduce waste motion and time to a minimum, yet keep the machine compact and simple to operate. These machines are built to be as rugged and foolproof as modern mechanical skill can make them, because a machine that is down is not producing. If you are considering a special single-purpose machine, you can be sure that Hartford Special will examine every angle to give your production a real boost. Write our Engineering Department now. The Hartford Special Machinery Company, Hartford 5, Connecticut.



Remember

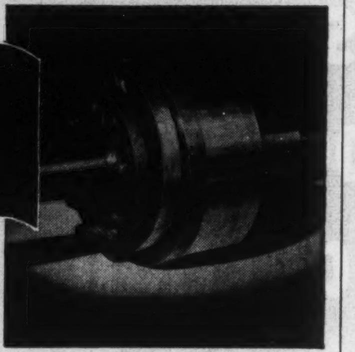
For special applications, Drilling and Tapping Units with or without attachable heads are available individually.

HARTFORD
Special
...the standard for special machinery

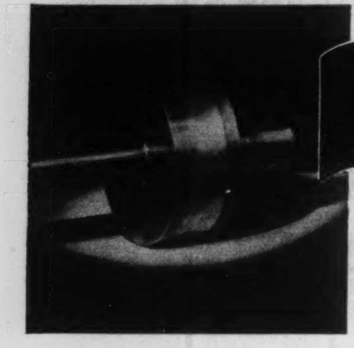
HILLIARD *Clutches*

FOR POWER CONTROL DESIGNS

HILLIARD
SINGLE
REVOLUTION
CLUTCH



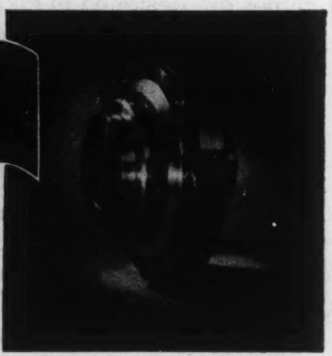
Unequalled for accurate control of intermittent machine operations — cutting, punching, and packaging. Gives closer tolerances to cut-off, stamping, shearing, and similar machines. Completely automatic; manual, mechanical, or electrical control.



HILLIARD
OVER-RUNNING
CLUTCH

Hilliard Over-Running Clutches and Couplings are automatic in operation. They are unexcelled for automatic two-speed drives, dual drives, stand-by drives, and for allowing machinery to "coast" after drive stops. Excellent as fixed or infinitely adjustable ratchets.

HILLIARD
SLIP
CLUTCH



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The HILLIARD Slip Clutch
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Hilliard's Engineering Department is ready to assist you in designing installations and in selecting the correct clutch or coupling.
Write today — 3 Hilliard Clutch Bulletins with design information. Free on request.

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SPEED REDUCERS—

THEY
ARE COMPLETELY DESCRIBED
IN OUR NEW CATALOG.

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Euclid Universal CAN MEET
YOUR DEMANDS
INEXPENSIVELY

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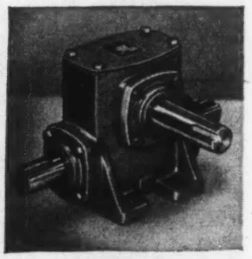
Write at once on your letterhead for your copy of our new Catalog 202-D.



Special heavy duty worm gear reducer with oversize worm shaft for use with heavy torque loads.

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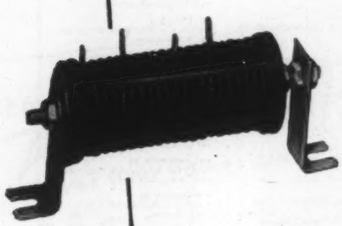
UNITED-CARR FASTENER CORP.
Cambridge 42, Mass.

MAKERS OF DOT *FASTENERS*

Pick the Rectifier to fit your need

Each of these three popular metallic rectifiers, copper oxide, low-voltage selenium, and high-voltage selenium, has its own characteristics which make it a better rectifier for a particular application. As the best choice depends on the desired application characteristics, here are some general characteristics:

	Characteristics	Application
	Copper Oxide Always formed blocking layer Heavy overload, voltage and current, of short duration High efficiency at high current densities Stabilized "aging" after few months Continuous service Long life	Blocking relays in control circuits Circuit breaker Plating equipment Exciter circuits Relay power supply Battery chargers
	Low-voltage Selenium Generally offers the best compromise between the features of high-voltage selenium and stability of efficiency of copper oxide.	Cathodic protection Magnetic separators Battery eliminators Elevator controls
	**High-voltage Selenium** Smaller in size per volt over 12 Light weight High voltage, low current Suitable for economical intermittent service over 12 volts	Calculating machines Aircraft Arc suppressor Coin machines

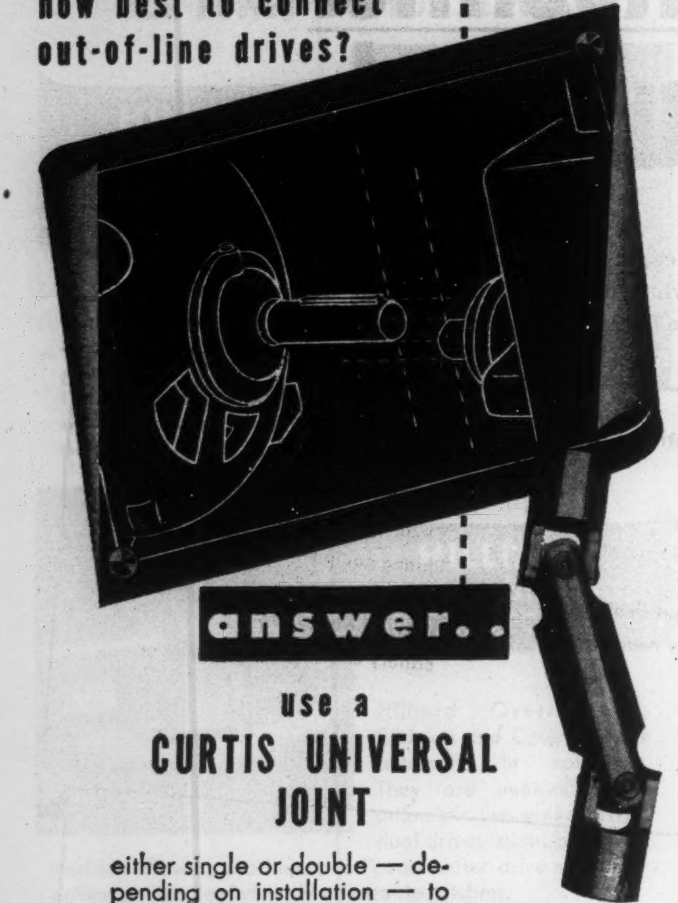
To fully meet your needs, General Electric makes all three types. If you have a rectifier problem, bring it to us—we play no favorites, we will give you an impartial recommendation. Contact your local G-E Apparatus Agent, or write *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

GENERAL ELECTRIC

456-17

problem...

how best to connect out-of-line drives?



answer..

use a CURTIS UNIVERSAL JOINT

either single or double — depending on installation — to secure positive, efficient, troublefree power transmission.

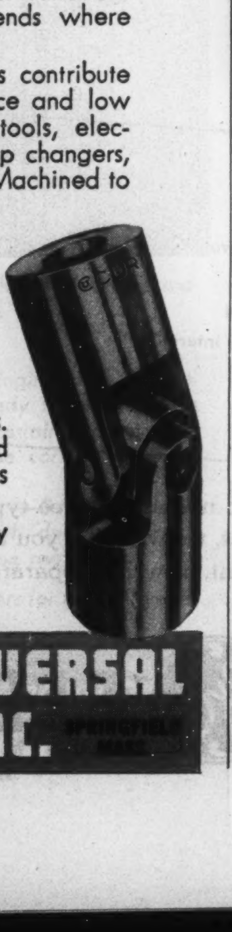
Curtis Universals insure delivery of positive rotation to driven shaft from driving shaft and can permit compensation for variations in distances between shaft ends where necessary.

Curtis Quality Universal Joints contribute to efficient, smooth performance and low maintenance of your machine tools, electronic apparatus, transformer tap changers, multi-spindle drill heads, etc. Machined to the closest practical tolerances from special heat treated alloy steels, the precision and quality of Curtis Universals are zealously watched by experienced craftsmen—many of whom have been with Curtis for years.

Available from stock in 14 sizes. Either single or double, furnished with solid hubs or with hubs bored one half the O.D.

Be sure of the best — Specify Curtis.

Write Dept. B



CURTIS UNIVERSAL JOINT CO. INC. SPRINGFIELD MASS.

CASE REPORT No. 53 from a series of actual cases recording the successful application of "BEAR" DY-NAMIC BALANCING to Industry.

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BIRD MACHINE CO., SOUTH WALPOLE, MASS. reports: Bird Centrifugal Filters are used throughout industry to separate solids from liquids. These machines must be **precision-built** because they handle solids as fine as a fraction of a micron or tonnages as high as 60 tons per hour. All rotating parts are "Bear" Dy-Namically Balanced . . . we obtain accurate results as well as efficient production.

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"Bear" Dy-Namic Balancing is making its weight felt in every phase of industry by helping to increase sales appeal and adding value to hundreds of products...from tiny electric motors to washing machines and railroad wheels. By the revolutionary "Bear" Method both Dy-Namic and Static Balance are attained in one time-saving operation, which need not interrupt routine production and may be installed with low initial capital investment.

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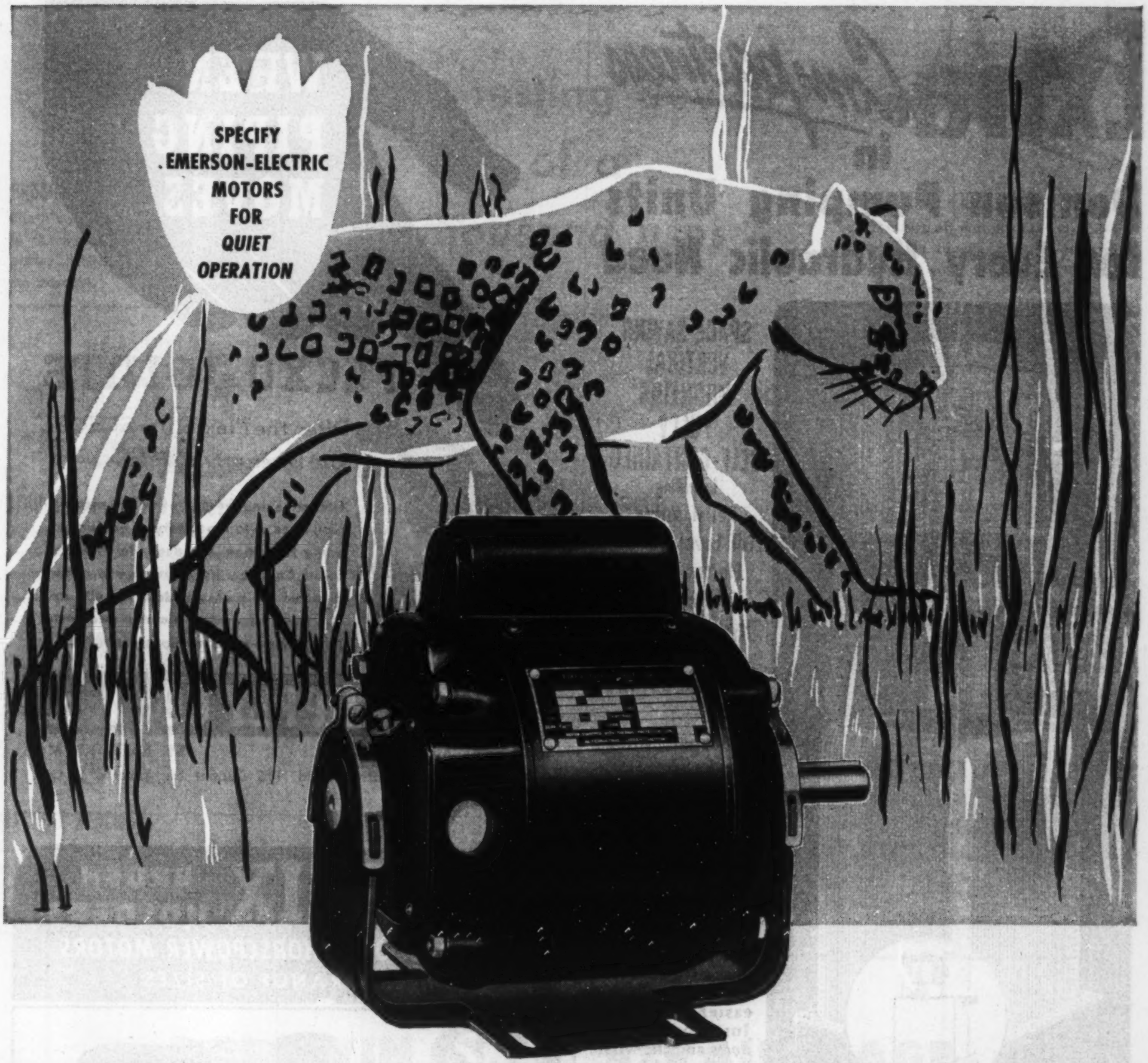


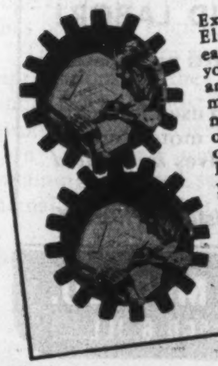
Leading products feature quiet power

A quiet operating mechanism is a sales advantage. It will pay you to consider the *heart* of your product—the motor—in the light of the enviable record Emerson-Electric Motors have established for quiet operation on scores of America's most reputable products.

The consistently quiet operation of Emerson-Electric Motors is a natural "by-product" of a 60-year-old tradition of *precision* manufacturing . . . enforced by literally hundreds of exacting tests and inspections at every stage of production . . . and backed by unsurpassed research and designing facilities, plus experience.

In addition to the advantage of *quiet* power, Emerson-Electric Motors give your products greater dependability, longer life and require less servicing. Your inquiry is invited on a complete line of NEMA standard or special purpose motors, 1/20 to 5 h.p.

Emerson-Electric's unique *Twingineering* SERVICE solves your power problems



Experienced Emerson-Electric Engineers are eager to collaborate with your own staff in designing and providing the proper motor application to your new or improved appliance or equipment. Such collaboration—TWIN-GINEERING we call it—can save you costly engineering "back-tracking," and may suggest short cuts or improvements of great competitive benefit to your product. Write us today . . . there is no charge for this service.

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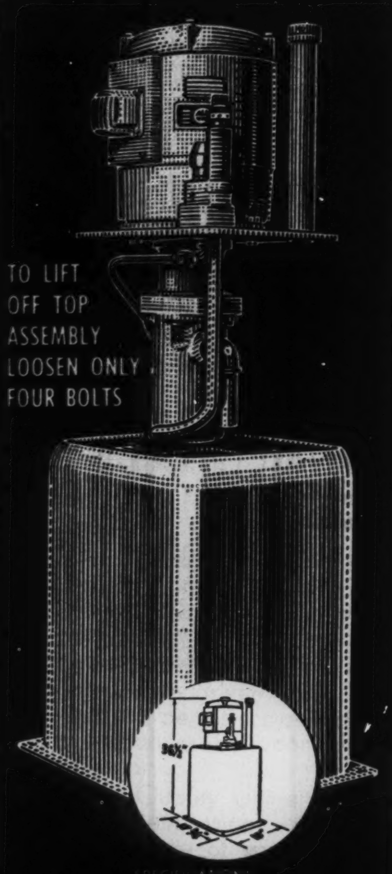
Extra *Compactness* in Denison Pumping Units for Every Hydraulic Need



TO LIFT OFF TOP ASSEMBLY LOOSEN ONLY FOUR BOLTS
36½"

SPACE-SAVING VERTICAL MOUNTING FULLY SELF-CONTAINED
including
Relief Valve
Oil Level Gauge
Electric Motor
Oil Reservoir
Hydraulic Pump
Oil Cooler
Pressure Gauge

Packaged power is at its best in these compact and completely self-contained DENISON hydraulic pumping units. They feature an advanced type of vertical assembly—which simplifies their construction, lowers their cost, makes them far more rugged and easier to service. Just loosen *four bolts* and the whole top assembly, including electric motor, hydraulic pump, pressure relief valve, piping and mounting plate, can be lifted off the reservoir as a single unit! These efficient pumps provide a range of pressures up to 2500 psi; volume output ranging from 2 to 11 gpm. ***Write for details!***

SPECIFICATIONS

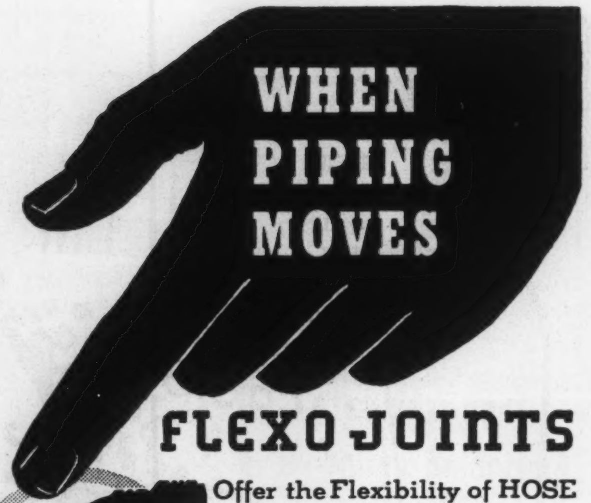
MODEL	GPM at 0 PSI	MAX. PUMP PRESSURE	MOTOR
PUG2	2	1000 psi	1½ hp 1800 rpm
PUG3	3.5	1000 psi	1½ hp 1800 rpm
PU3	3	2500 psi	3 hp 1800 rpm
PUF3	3	2500 psi	5 hp 1800 rpm
PUV5	5	1000 psi	3 hp 1800 rpm
PUF7	7.25	2000 psi	5 hp 1800 rpm
PUS7	7.25	2500 psi	7½ hp 1800 rpm
PUV7	7.5	1000 psi	3 hp 1800 rpm
PUFV7	7.5	1000 psi	5 hp 1800 rpm
PUS9	9	2000 psi	7½ hp 1800 rpm
PUV11	11	1000 psi	3 hp 1800 rpm
PUFV11	11	1000 psi	5 hp 1800 rpm
PUS11	11	1000 psi	7½ hp 1800 rpm

*See catalog for intermittent ratings

The DENISON Engineering Co.
1156 Dublin Road
Columbus 16, Ohio

HydrOILics INDUSTRY'S RIGHT HAND

DENISON EQUIPMENT for APPLIED HydrOILics



FLEXO JOINTS

Offer the Flexibility of HOSE the Strength of PIPE

For conveying pressures through moving pipe lines or to machinery or equipment while in motion, use dependable Flexo Joints. Complete 360° movement in either direction for pressures from gravity up . . . long wear—low maintenance cost. Four styles—standard pipe sizes ¼" to 3".

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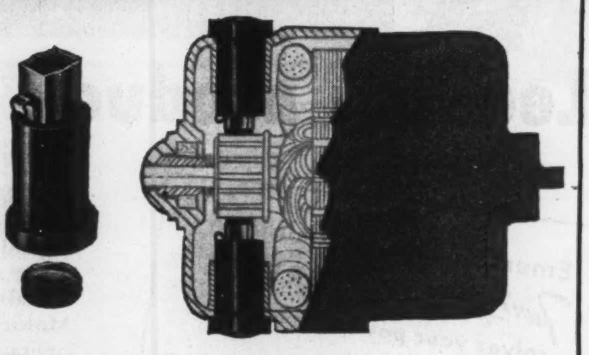
PHOENIX BRUSH HOLDERS
FOR FRACTIONAL HORSEPOWER MOTORS
COMPLETE RANGE OF SIZES. . . .



SAVES ASSEMBLY TIME AND LABOR!

Made in a complete range of standard and special sizes for fractional H.P. motors.

PHOENIX Brush-Holders have been used for years by many of the country's leading motor manufacturers. They have proven themselves *in the field* under almost every condition.

Improve your operation, cut your costs, investigate PHOENIX.

PHOENIX ELECTRIC MFG. CO.
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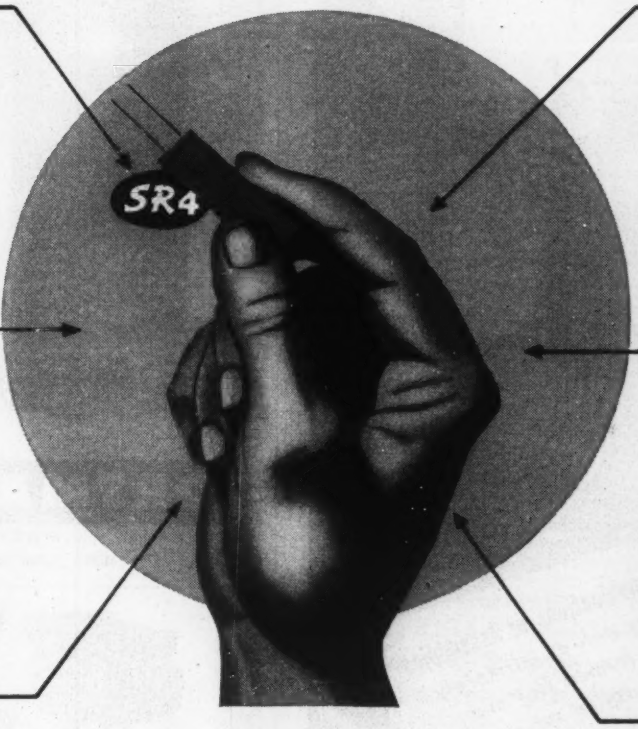
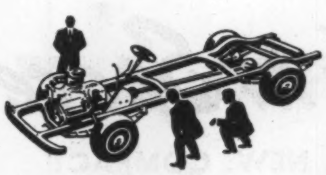
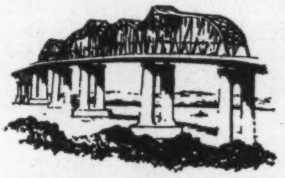
The testing device of a *thousand uses*





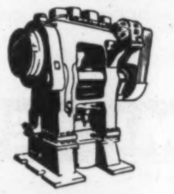
PRODUCT IMPROVEMENT

The Automotive Industry uses the SR-4 to check stresses and strains in vital parts, eliminate weaknesses, improve the product.



STRUCTURAL STRESS ANALYSIS

Engineering organizations check theoretical stress distribution against actual patterns, to verify design practice.

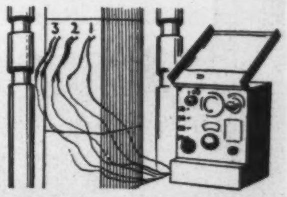


MACHINE REDESIGN

Equipment manufacturers use the SR-4 to isolate the cause of puzzling breakages and to point the way to a correct solution.

AIRCRAFT LIGHTENING

The Aircraft Industry uses the SR-4 to plot the complex flow of stresses in aircraft wings during flight, "balance" the design.



MASONRY STRESS DETERMINATION

The heavy construction industry is learning valuable new facts on how masonry withstands loading . . . with the SR-4.

MAKING BALLISTICS STUDIES

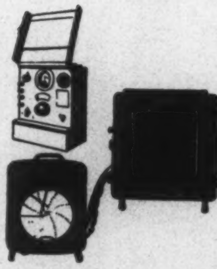
The flow of stress in a gun barrel as the bullet passed through was once a matter of theory... but a matter of accurate knowledge now, because of the SR-4.

BALDWIN SR4* STRAIN GAGE

It's hard to believe—yet this one little testing device, no larger than a postage stamp, has done more to broaden engineering knowledge through product analysis than all other testing equipment combined:

It has provided—for the first time—an accurate picture of actual stress distribution in such structural, equipment and machine parts as an airplane wing in flight . . . the interior of a mammoth masonry dam . . . the barrel of a cannon when the shell flashes from breech to muzzle . . . the frame of a punch press . . . the connecting rods of diesel engines during operation. In every instance, the new knowledge it revealed has permitted engineers to better the design job.

The long list of successful uses does not define the ultimate applications of the Baldwin SR-4 strain gage, but merely indicates its almost limitless possibilities. If you have any problem where unexplainable failures of parts are puzzling you . . . where some equipment must be lightened while retaining balanced strength . . . where a complete report of actual stress distribution in a structure will aid you in design . . . the Baldwin SR-4 can undoubtedly help you, as it has helped many others.



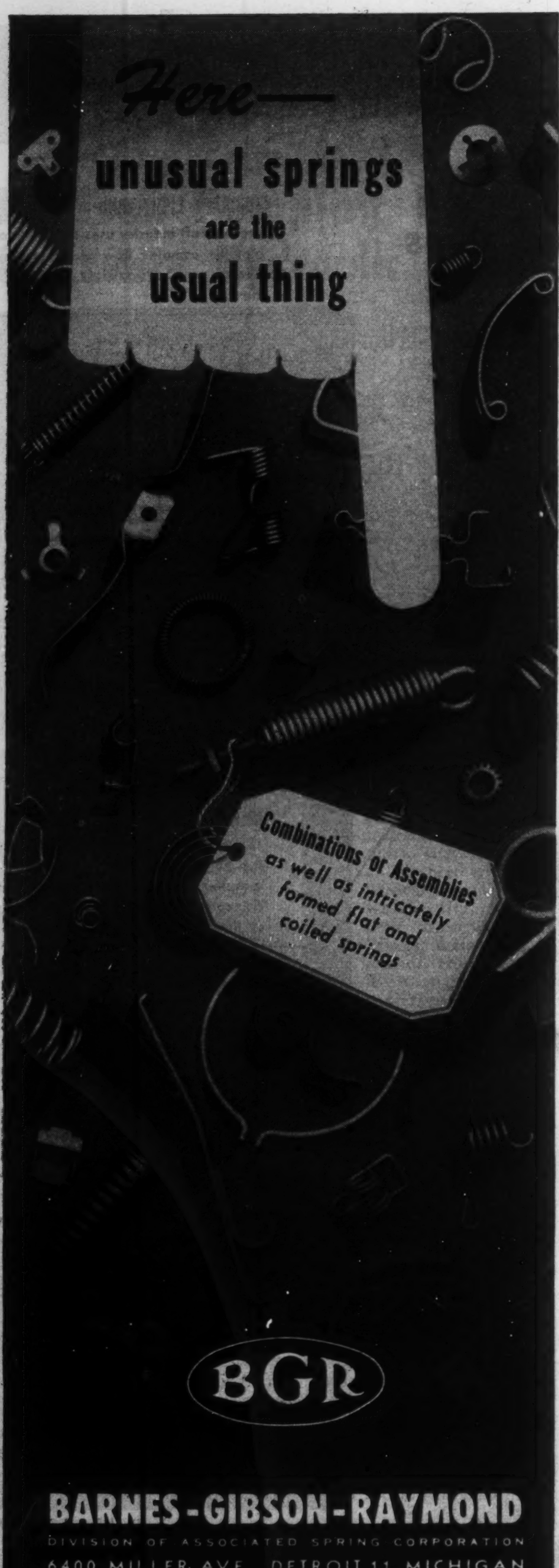
A comprehensive line of indicating, recording and switching instruments and equipment is available for both laboratory and field studies. The units illustrated include an SR-4 Strain Recorder Chart, and SR-4 Portable Strain Indicator, and an SR-4 Switching Unit, with which 48 strain gages can be switched in and out of service in as little as 50 seconds. These are only a few of many.

ASK FOR LITERATURE. Informative Technical Bulletins give a concise technical description of the SR-4 and collateral equipment. Ask for copies, indicating the type of testing in which you are interested.

The Baldwin Locomotive Works, Philadelphia 42, Pa., U. S. A. Offices: Boston, Chicago, Cleveland, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Seattle, St. Louis, Washington. In Canada: Peacock Brothers, Ltd., Montreal, Quebec.

*T. M. Reg. U. S. Pat. Off.

TESTING HEADQUARTERS BALDWIN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usual thing
Combinations or Assemblies
as well as intricately
formed flat and
coiled springs
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No bolts or screws . . .circumferential keys allow repacking in a matter of minutes. All machined steel with bronze bearing surfaces. Ports adjustable to any angle. Simplified cushion, no ball check required. Mountings interchangeable without dissassembling cylinder. 1,500 cycles per minute continuous duty guaranteed.
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It's RUTHMAN GUSHER COOLANT PUMPS

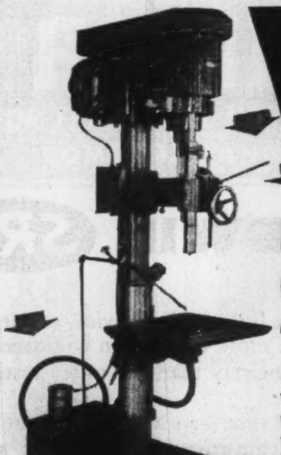

Photo Courtesy of Sibley Machine & Foundry Corp.

In all metal cutting operations, where correct coolant flow is essential to efficient, fast production, Ruthman Gusher Coolant Pumps give outstanding performance. Efficient in operation, Gusher Coolant Pumps are low in initial cost, easy to install, and economical to operate. To end your coolant worries insist on Ruthman Gusher Coolant Pumps on all your metal cutting equipment.

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Illustrated is a Sibley model C-20 Drilling machine equipped with model 1-P3-9030 Short 1/10 HP Ruthman Gusher Coolant Pump

THE RUTHMAN MACHINERY CO.

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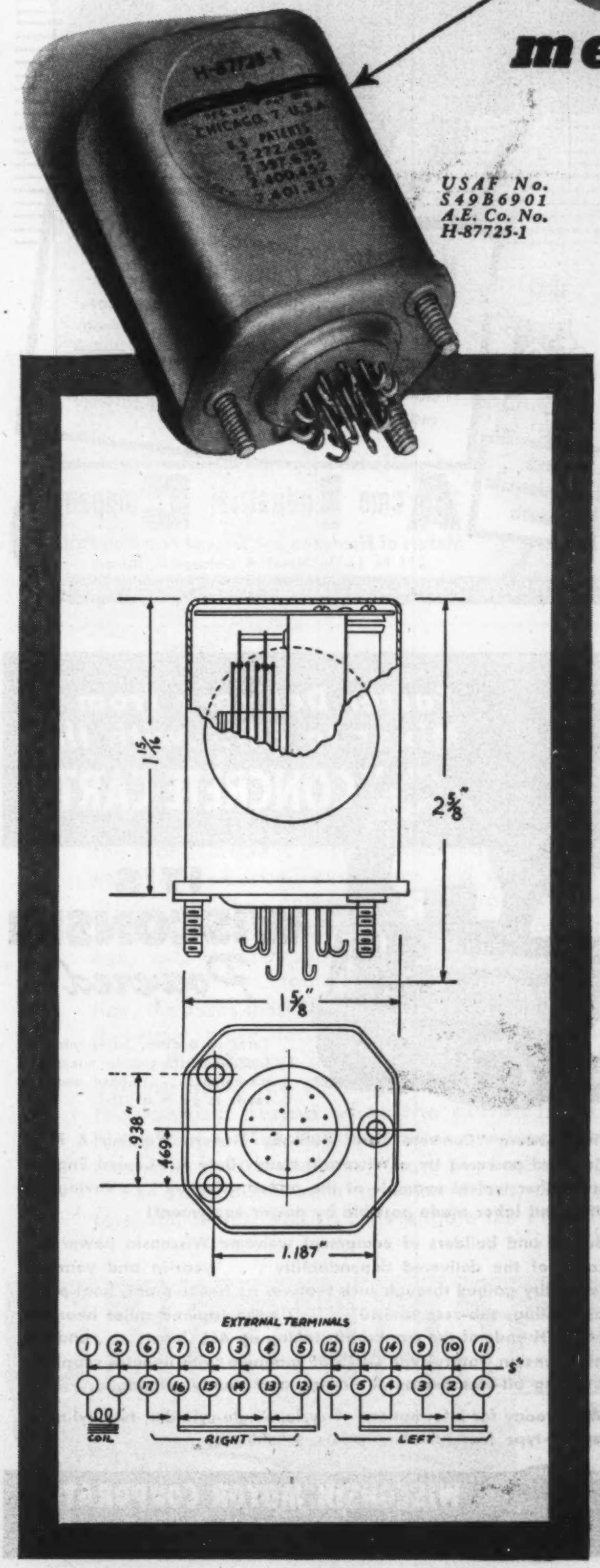
means


H-87725-1
CHICAGO 7, U.S.A.
U.S. PATENTS
1 5/16
2 5/8"
1 5/8"
.938"
.469
1.187"
EXTERNAL TERMINALS
1 2 6 7 8 3 4 5 12 13 14 9 10 11
17 16 15 14 13 12 6 5 4 3 2 1
S*
COIL
RIGHT
LEFT

USAF No.
S49B6901
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THIS RELAY IS *GOOD!*

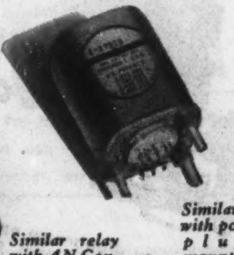
The coveted "Yellow Dot" signifies this relay meets USAF requirements for reliable operation under extremes of altitude, temperature, humidity, shock and vibration.

Whether or not your product is destined for Air Force applications, you benefit by using a relay which has type approval under such exacting specifications.

The hermetically sealed Class "S" Relay at the left is USAF Type S49B6901, 24-volt DC coil, 4-pole double throw contact spring combination, wired and terminated as shown.

Other telephone type relays can be supplied with or without hermetically sealed enclosures. For additional information, send for Circulars 1700 and 1702. Write AUTOMATIC ELECTRIC SALES CORPORATION, 1033 W. Van Buren St., Chicago 7, Illinois. In Canada: Automatic Electric (Canada) Limited, Toronto.

Similar relay with AN Connector A.E. Co. No. H-87312



Similar relay with polarized plug-in mounting for miniature type socket A.E. Co. No. H-870005-1

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- We can provide special valves in all classifications, if standard valves will not fill requirements.
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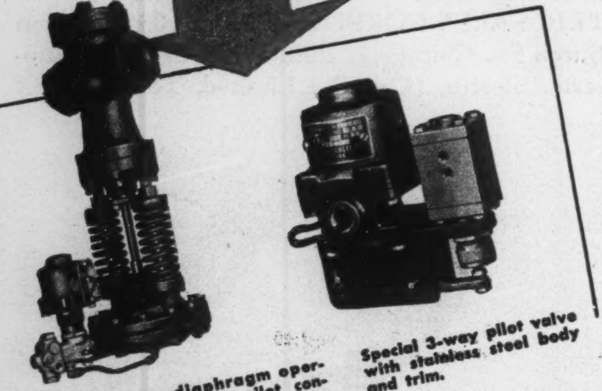

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Special 3-way pilot valve with stainless steel body and trim.

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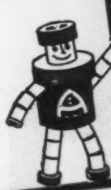

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Buyers and builders of equipment welcome Wisconsin power because of the delivered dependability . . . year-in and year-out reliability gained through such features as freeze-proof, heat-proof air-cooling, sub-zero to 140° . . . Timken tapered roller bearings at BOTH ends of the crankshaft, taking up ALL thrusts . . . and the high-tension, rotary-type OUTSIDE magneto with impulse coupling, assuring all-weather quick starting and steady running.

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MOST H.P. HOURS

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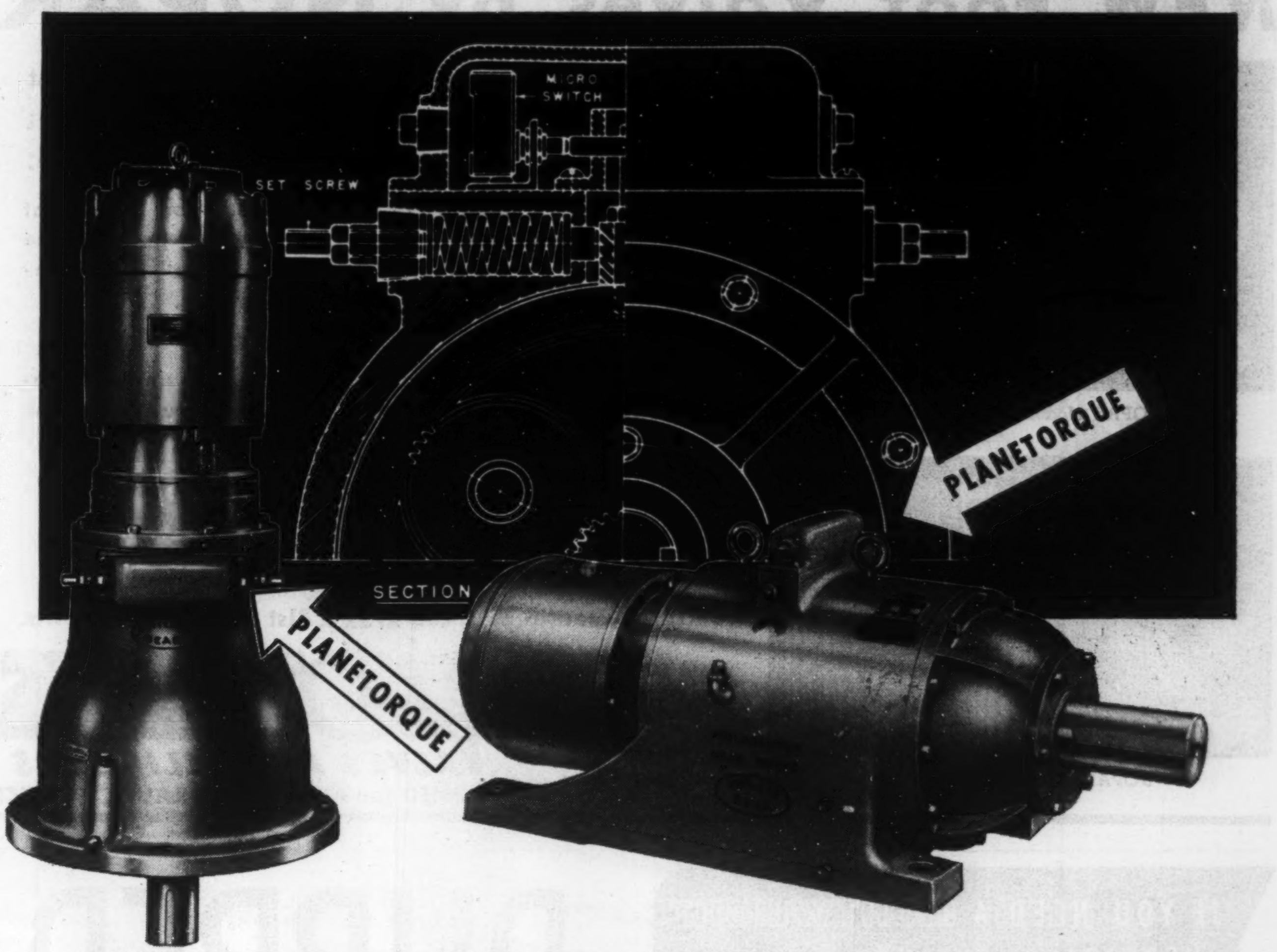
PHILADELPHIA PLANETORQUE MOTOREDUCER



..GIVES INSTANT OVERLOAD PROTECTION

The **PlaneTorque** is a feature that may be supplied with any Philadelphia MotoReduceR *(combined motor and speed reducer)* to *protect* both the driven machinery and the drive unit from overloads.

By direct mechanical action of the overload, motor current is *automatically and instantly cut off* when a pre-determined limit is reached. This action is quicker than electrical thermal relays provide. (With fuse protection, the fuses must be selected to carry the starting current of the motor; therefore, protection during running period is not adequate.)

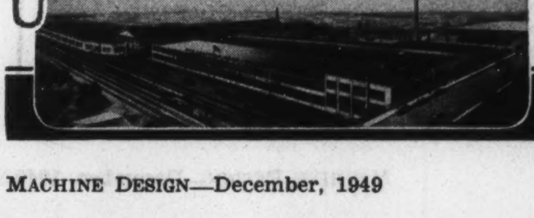
The **PlaneTorque** can be cut-out during the starting period merely by holding down the starting button, but will become operative during the running period when the button is released. To restart the **PlaneTorque MotoReduceR** after overload cut-off, *only removal of the excessive load is necessary* . . . a big time saving feature.

For applications such as stoker drives, conveyor drives, mixers, agitators, roll drives, etc. . . . investigate the **PlaneTorque MotoReduceR**.

Philadelphia
MotoReduceR

Send for new Catalog MR-49, and please use your Business Letterhead when writing.

Philadelphia Gear Works, INC.



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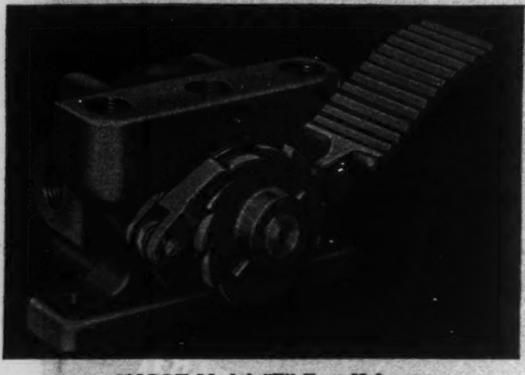
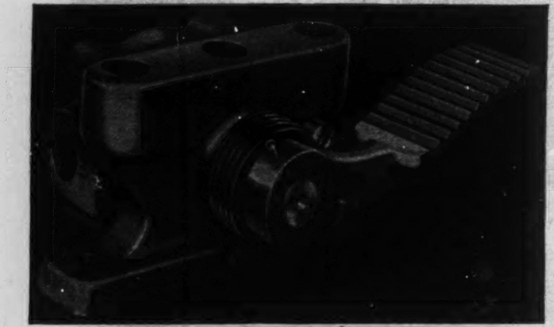
NEW Foot Valves by NOPAK



NOPAK Model "F" Foot Valve



NOPAK Model "R" Foot Valve

These new Model "F" and Model "R" Foot Valves embody a number of installation and operating advantages which include:

- **Eliminating the internal exhaust core in the valve disc.**
- **Larger *effective* exhaust area . . . increases valve capacity.**
- **Reduced possibility of plugged passages.**
- **"Exhaust" port located at top of valve, between the two "cylinder" ports, simplifies piping.**
- **Reduced overall height.**
- **Compact streamlined appearance, more eye-appeal.**

Designed primarily for air service, both valves may be adapted to oil or water hydraulic service, for pressures up to 100 P.S.I., at slight extra cost. For complete Description and Specifications, see NOPAK Foot Valve Bulletin.

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VALVES AND CYLINDERS

DESIGNED for AIR and HYDRAULIC SERVICE

A 5626-½H-AA

IF YOU NEED A **LIGHTWEIGHT** VERSATILE ENGINE . . .

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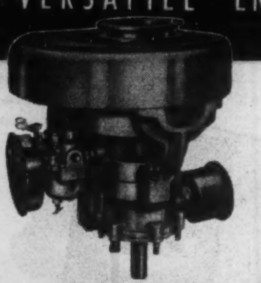

2 TO 3 H.P.
18 LBS.

SENSATION MONO-CYCLE ENGINE HAS MANY FEATURES YOU'LL WANT TO KNOW ABOUT

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Please rush me your illustrated folder giving specifications and mechanical data on the Sensation Mono-Cycle Engine.

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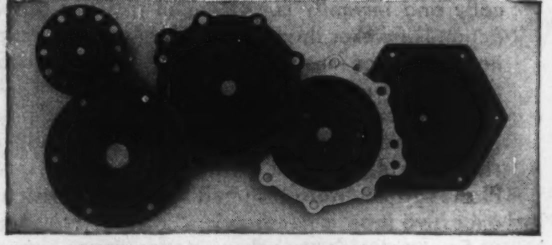

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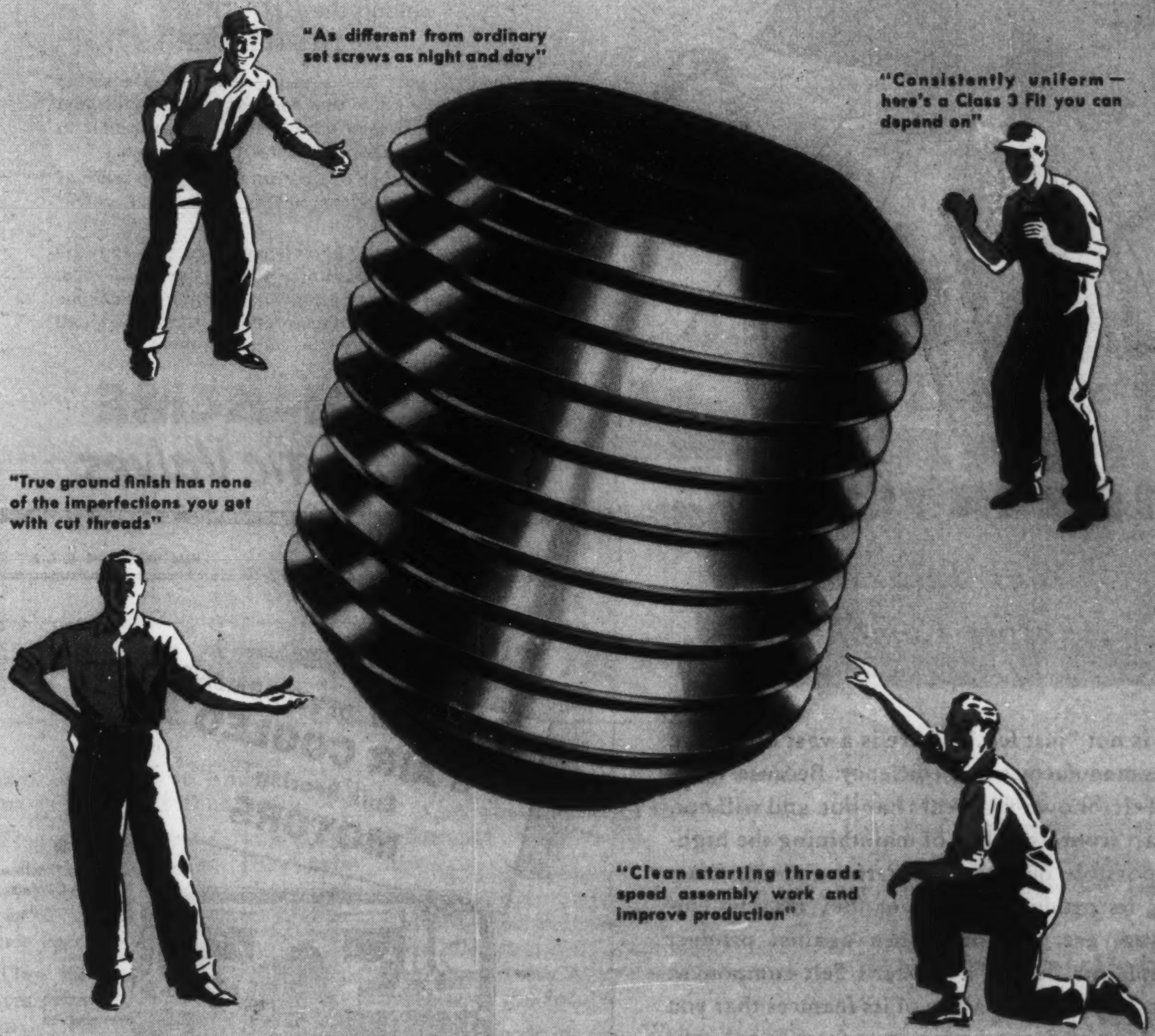
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"Consistently uniform — here's a Class 3 Fit you can depend on"
"True ground finish has none of the imperfections you get with cut threads"
"Clean starting threads speed assembly work and improve production"

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See why P-K Ground Thread Socket Set Screws speed assemblies, improve strength and safety. Thread grinding, once reserved for screws used in the finest precision equipment, now gives Parker-Kalon Socket Set Screws the accurate finish and faultless contour that mean faster assembly and more sales for your products. Write for samples today.

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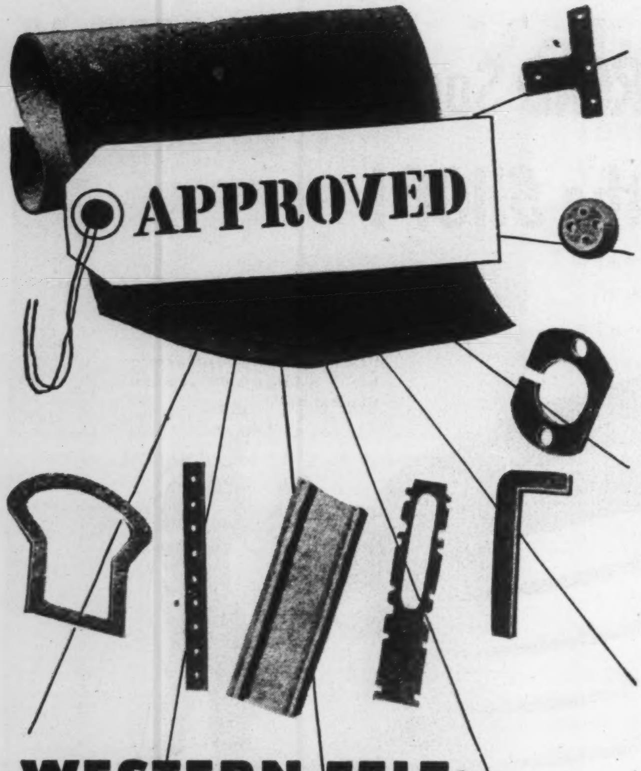

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behind the man
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We remember this truism with a deep sense of responsibility when making Cash-Acme valves for industry.

And when our valves leave the factory en route to your plant, we know that so-far is so-good. You have selected a dependable product and gone far to guarantee the safety of human life and property entrusted to your judgment.

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Automatic Valves

A. W. CASH VALVE MANUFACTURING CORPORATION

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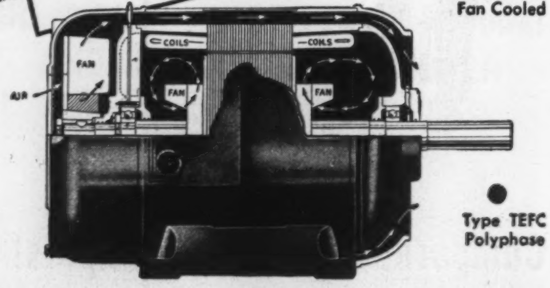

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Here is the newest and most successful development in air cooled motors. Totally enclosed, constant speed, continuous duty; it is designed for cooler and more economical operation under the hardships of extreme heat and dust. Fully ball bearing and quiet running, too. You will want to know more about this *new* VALLEY Motor.

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Let's keep America that way . . . the hope of the world.

Let's make sure that our freedom is not stolen. And let's keep right on raising our standard of living . . . making sure that there will be still more for every American to have and enjoy in the future.

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Then it will be possible for all Americans to keep on producing more and more goods . . . working shorter hours . . . and enjoying an ever higher standard of living.

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Randall *graphited bronze* bushings . . . or self-lubricating, self-aligning pillow blocks

Shafts roll smoother, quieter, longer, on Randall graphited bronze bushings. You get the toughness and heat resistance of phosphor bronze, plus the dependable lubrication of graphite that's actually part of the bearing surface.

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Write for Bushing Catalog GB-43 or Pillow Block Catalog 49.

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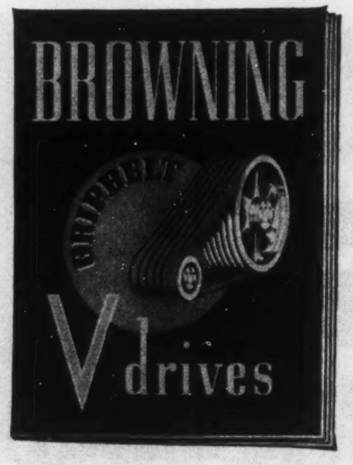
609 West Lake St., Dept. 1217, Chicago 6, Illinois



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RAISE • LOW SLOW
OFF • STO • GO
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LOWE RE FAST • SHUT •
OFF • AISE • STOP • OPEN • GO
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Match Your POWER with LOVEJOY L-R FLEXIBLE COUPLINGS

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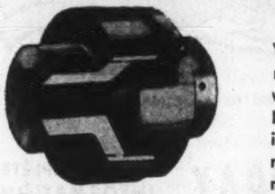
speed-up
smooth power flow
full production
freedom from
shut-downs



Type "H" with special safeguard. Pat. & Pats. Pend.

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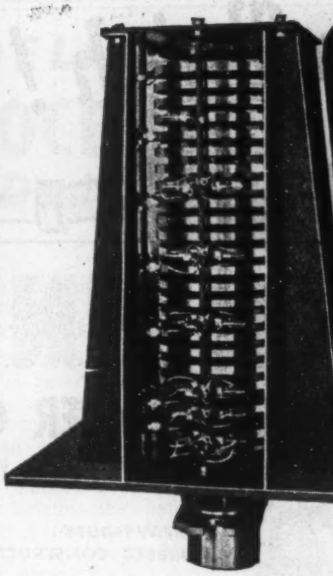

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Welco Collector Rings are custom-built to fit the special design and functional requirements of your machines or equipment. A limited number of standard types are available. Send us your blueprints and we will design for you the collector rings that are functionally correct.

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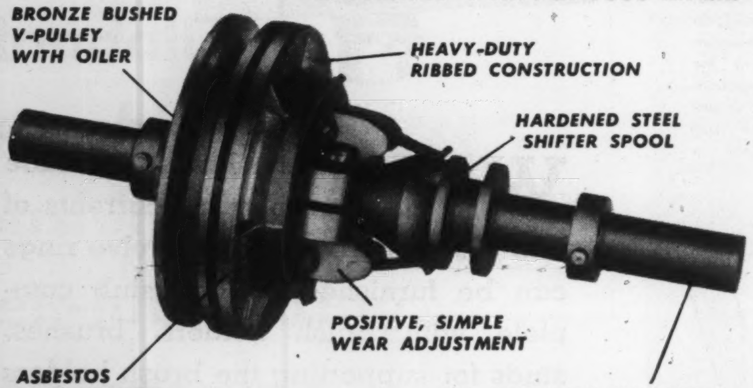
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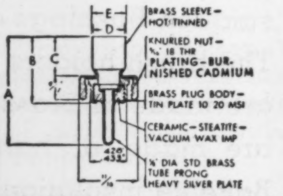
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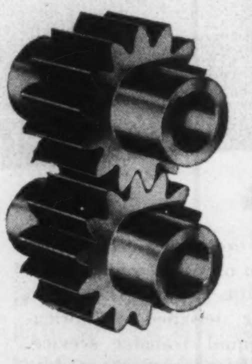

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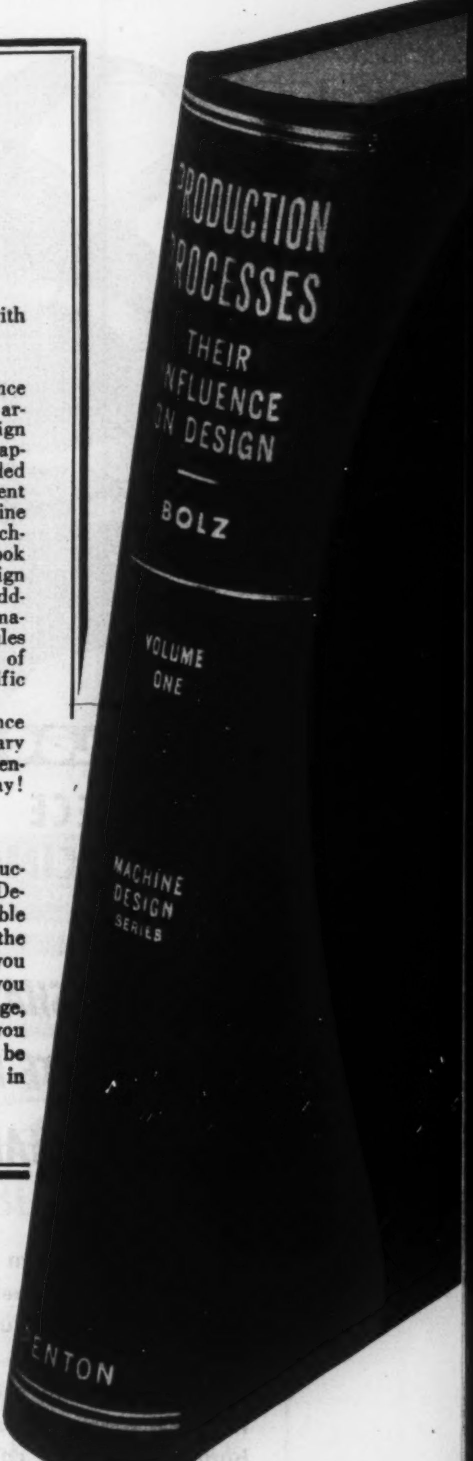

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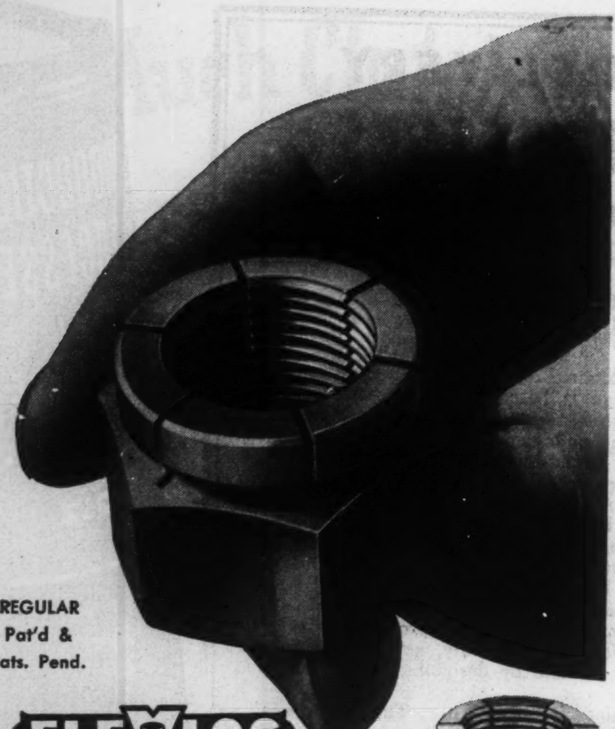

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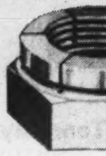

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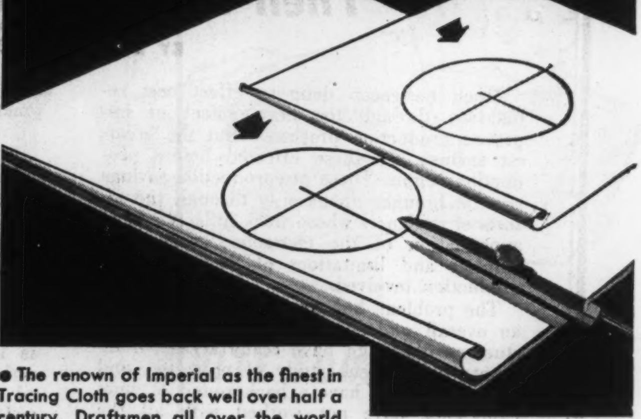

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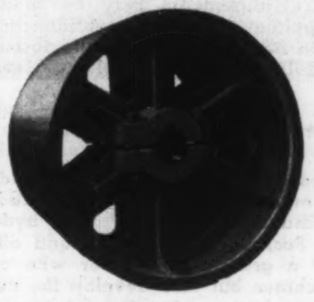
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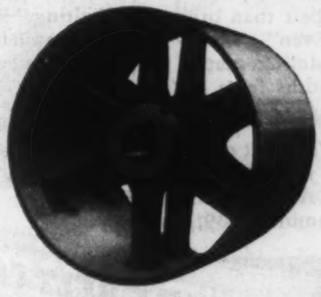
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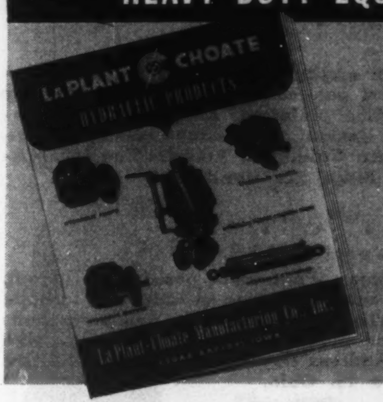

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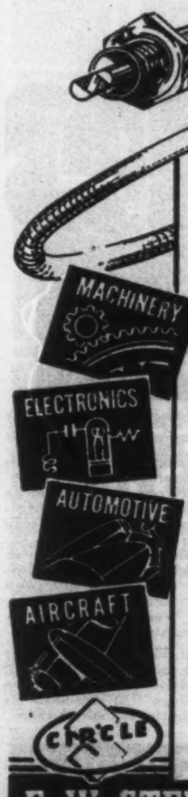

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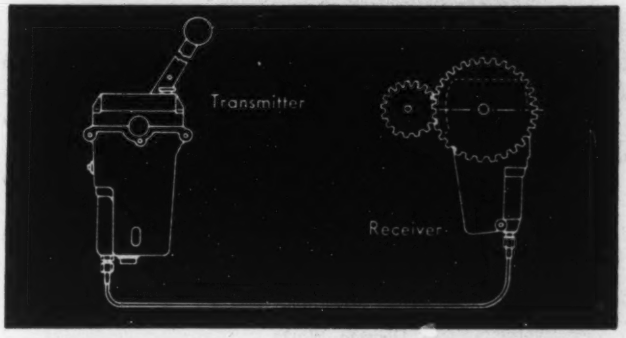

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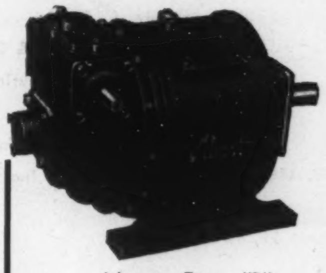

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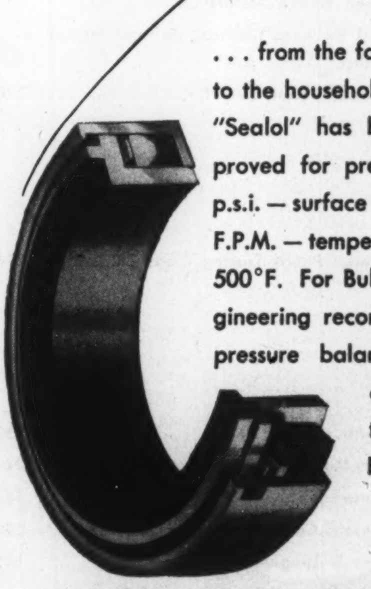

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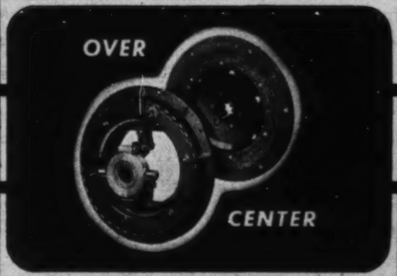

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ADVERTISING INDEX

A

Abart Gear & Machine Co. 277
Accurate Spring Manufacturing Co. 232
Acme Industrial Co. 264
Acushnet Process Co. 266
Ajax Flexible Coupling Co., Inc. 245
Alan Wood Steel Co. 202
Allegheny Ludlum Steel Corp. 43
Allen-Bradley Co. 67, 68
Alliance Manufacturing Co. 254
Allis-Chalmers 54, 55
Aluminum Company of America .22, 175, 241
Aluminum Industries, Inc. 59
American Brass Co., The 29, 97
American Brass Co., The, American Metal Hose Branch 71
American Crucible Products Co., The 226
American Machine and Metals, Inc., United States Gauge Division 8
American Manganese Bronze Co. 276
American Metal Hose Branch, American Brass Co., The 71
American Pulley Co., The 218
American Screw Co. 282
American Welding and Manufacturing Co., The 215
Amgears, Inc. 224
Ampco Metal, Inc. 206
Amplex Manufacturing Co., Division of Chrysler Corp. 93
Arma Corp. 75
Armstrong Cork Co. 171
Austenal Laboratories, Inc., Microcast Division 92
Automatic Electric Sales Corp. 263
Automatic Switch Co. 264

B

Babcock & Wilcox Tube Co., The 219
Baldor Electric Co. 11
Baldwin Locomotive Works, The 261
Barnes-Gibson-Raymond, Division of Associated Spring Corp. 262
Barnes, Wallace, Co. 84
Barry Corp., The 226
Bear Manufacturing Co. 258
Bodine Electric Co. 20, 21
Bound Brook Oil-Less Bearing Co. 178
Brown & Sharpe Manufacturing Co. 89
Browning Manufacturing Co., Inc. 270
Bruning, Charles, Co., Inc. 222
Bundy Tubing Co. 90
Bunting Brass & Bronze Co., The 279

C

Cambridge Wire Cloth Co. 176
Cash, A. W., Valve Manufacturing Corp. . 268
Chain Belt Co. 60, 61
Chicago Rawhide Manufacturing Co. 2, 45
Cincinnati Gear Co., The 272
Clare, C. P., Co. 95
Cleveland Worm & Gear Co., The 87
Clifford Manufacturing Co. 27
Crane Co. 246
Curtis Universal Joint Co., Inc. 258
Cutler-Hammer, Inc. ......Inside Front Cover

D

Delco Products, Division of General Motors Corp. 83
Denison Engineering Co., The 260
Diamond Chain Co., Inc. 77
Dodge Manufacturing Corp. 96
Dow Corning Corp. 188
du Pont de Nemours, E. I., & Co., Inc. .. 23

E

Eastman Kodak Co. 179, 207
Eaton Manufacturing Co., Reliance Division 80
Elastic Stop Nut Corporation of America . 211
Electric Motor Corp. 274
Electrical Engineering and Manufacturing Corp. 49
Electrol, Inc. 220
Elliott Manufacturing Co. 224
Emerson Electric Manufacturing Co., The . 259
Erie Bolt & Nut Co. 184
Euclid Universal Machine, Inc. 256

F

Fairbanks, Morse & Co. 100
Fairfield Manufacturing Co. 230
Farrel-Birmingham Co., Inc. 40
Fasco Industries, Inc. 210
Fawick Airflex Co., Inc. 223
Federal Bearings Co., Inc., The 209
Federal Electric Products Co. 42
Federal-Mogul Corp. 74
Flexo Supply Co., Inc. 260
Foote Bros. Gear and Machine Corp. 53

G

Galland-Henning Manufacturing Co. 266
Gast Manufacturing Corp. 208
Gear Specialties 19
General Electric Co. 14, 15, 38, 39, 70, 198, 243, 257, 270
Gilmer, L. H., Co., Division of United States Rubber Co. 94
Gisholt Machine Co. 86
Gits Bros. Manufacturing Co. 48
Gleason Works 5
Goodrich, B. F., Co., The 10
Graham Transmissions, Inc. 180
Gray Iron Founders' Society, Inc. 4
Great Lakes Steel Corp. 99

H

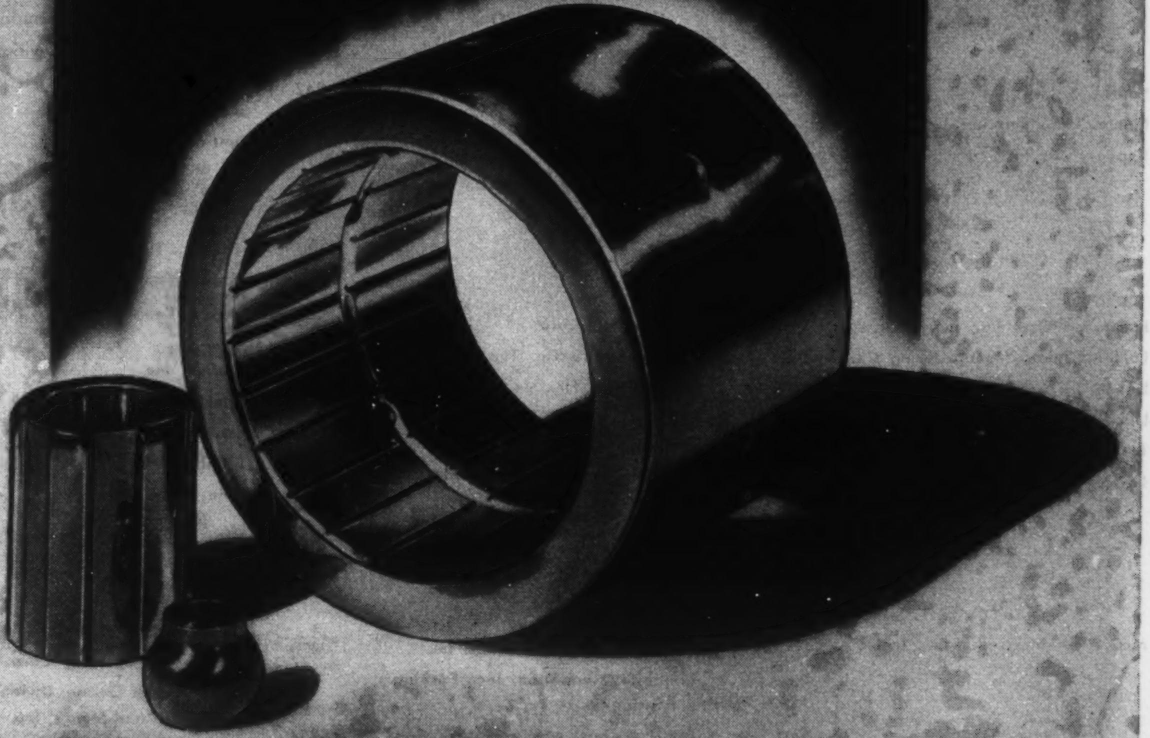
Hanna Engineering Works 52
Hannifin Corp. 44
Harper, H. M., Co., The 232
Hartford Special Machinery Co., The 255
Haskelite Manufacturing Corp. 227
Haynes Stellite Co. 58
Hevi Duty Electric Co. 252
Hilliard Corp., The 256
Holtzer-Cabot, Inc. 50
Hoover Ball and Bearing Co. 194
Houghton, E. F., & Co. 73
Howell Electric Motors Co. 247
Hyatt Bearings Division, General Motors Corp. 251
Hydraulic Equipment Co. 240

I

Imperial Pencil Tracing Cloth Co. 274

J

Jan-Air, Inc. 252
Johns-Manville 244
Johnson Bronze Co. 167
Johnson, Carlyle, Machine Co., The 250
Jones & Laughlin Steel Corp. 185
Jones, Howard B., Division of Cinch Manufacturing Corp. 272
Jones, W. A., Foundry & Machine Co. .. 275



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ADVERTISING INDEX

K

Keuffel & Esser Co. 62, 63
Kinney Manufacturing Co. 272
Koppers Co., Inc., Fast's Coupling Dept. 25

L

Laminated Shim Co., Inc. 204
LaPlant-Choate Manufacturing Co., Inc. 275
Linear, Inc. 24
Link-Belt Co. 13
Lord Manufacturing Co. 254
Lovejoy Flexible Coupling Co. 271

Mc

McGill Manufacturing Co., Inc. 72

M

Madison-Kipp Corp. 18
Mahon, R. C., Co., The 225
Manheim Manufacturing & Belting Co. 56
Master Electric Co., The Inside Back Cover
MB Manufacturing Co., Inc., The 253
Mechanics Universal Joint Division Borg-Warner Corp. 252
Meehanite Metal Corp. 205
Micro Switch, A Division of First Industrial Corp. 191
Miller Motor Co. 196, 197
Moraine Products, Division of General Motors Corp. 199
Morganite, Inc. 182

N

National Bearing Division, American Brake Shoe Co. 32
National Erie Corp. 12
National Motor Bearing Co., Inc. 79
National Screw & Manufacturing Co., The 169
New Departure, Division of General Motors Corp. 6
Nice Ball Bearing Co. 28
Norgren, C. A., Co. 57
Norma-Hoffmann Bearings Corp. 64

O

Ohio Gear Co., The 242
Ohio Seamless Tube Co., The 189
Oilgear Co., The 9
Ortman-Miller Machine Co., Inc. 262

P

Parker-Kalon Corp. 267
Peerless Electric Co., The 186
Pennsylvania Flexible Metallic Tubing Co. 41
Philadelphia Gear Works, Inc. 265
Phoenix Electric Manufacturing Co. 260
Pure Carbon Co., Inc. 190

R

Randall Graphite Bearings, Inc. 270
Raybestos-Manhattan, Inc., Packing Division 69
R-B-M Division of Essex Wire Corp. 254
Redmond Co., Inc. 217
Reeves Pulley Co. 30, 31
Reliance Division, Eaton Manufacturing Co. 80
Reliance Electric and Engineering Co. 35
Revere Copper and Brass, Inc. 213
Rockford Clutch Division, Borg-Warner Corp. 277
Roper, Geo. D., Corp. 212
Ross Heater & Manufacturing Co., Inc. 88
Ross Operating Valve Co. 1
Russell, Burdsall & Ward Bolt and Nut Co. 229
Ruthman Machinery Co., The 262
Rynel Corp. 228

S

Scovill Manufacturing Co. 195
Sealol Corp. 277
Sensation Engines 266
Shenango-Penn Mold Co. 183
Sivyer Steel Casting Co. 51
SKF Industries, Inc. 249
Speer Carbon Co. 81
Spencer Thermostat Division of Metals and Controls Corp. 66
Sperry Products, Inc. 277
Sponge Rubber Products Co., The 78
Standard Pressed Steel Co. 26, 274
Stewart, F. W., Manufacturing Corp. 275
Sundstrand Hydraulic Division, Sundstrand Machine Tool Co. 76
Superior Tube Co. 216
Syntron Co. 36

T

Thomson Industries, Inc. 200
Timken Roller Bearing Co., The 221, Back Cover
Titeflex, Inc. 230
Tomkins-Johnson Co., The 82
Torrington Co., The 91
Tuthill Pump Co. 271
Twin Disc Clutch Co. 187

U

Union Carbide and Carbon Corp. 58
United-Carr Fastener Corp. 256
United States Gauge, Division of American Machine and Metals, Inc. 8
United States Graphite Co., The, Division of The Wickes Corp. 16, 17, 203
U. S. Electrical Motors, Inc. 201

V

Valley Electric Corp. 268
Veeder-Root, Inc. 281
Vickers, Inc. 85
Viking Pump Co. 258

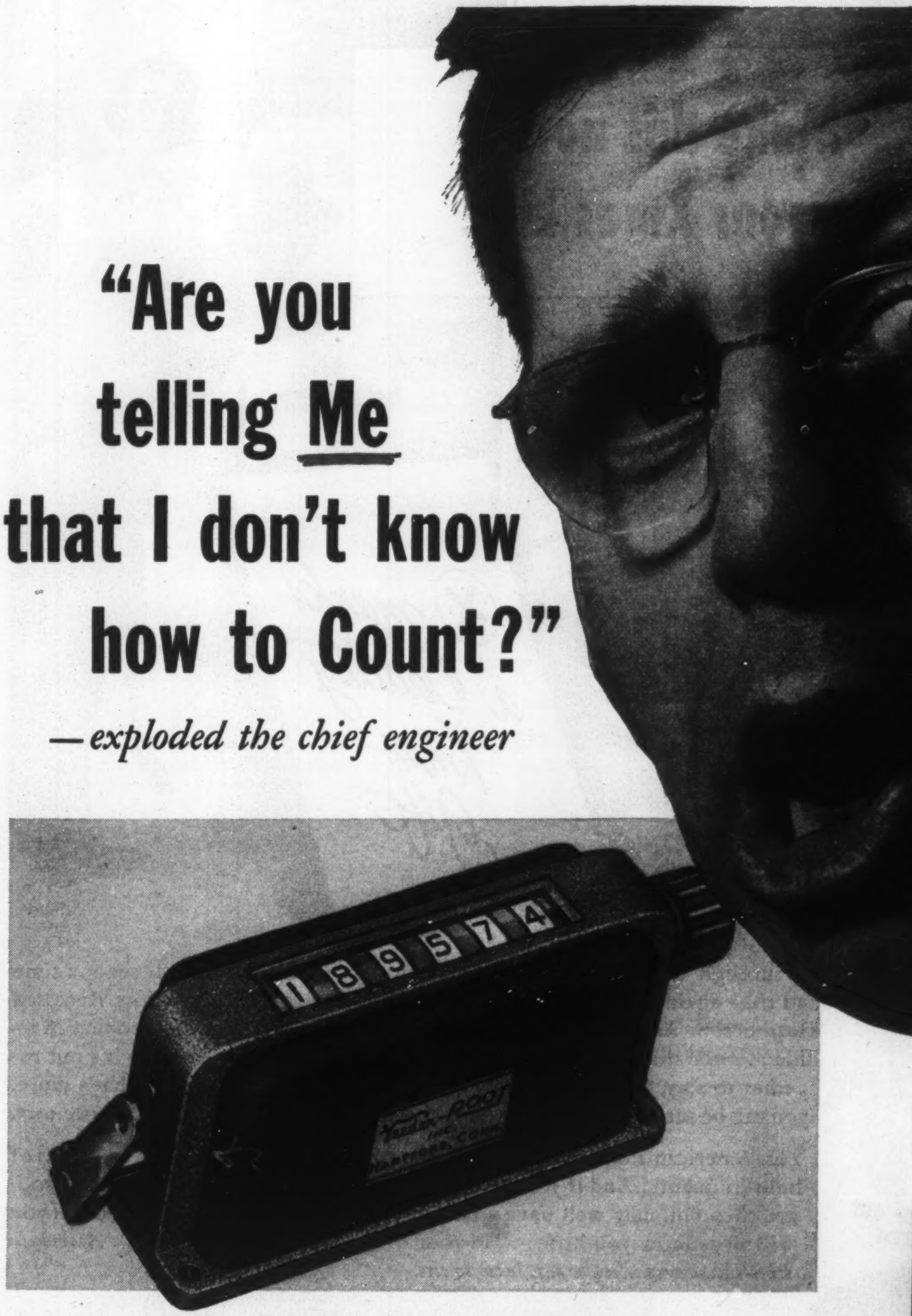
W

Ward Leonard Electric Co. 192, 193
Warner Electric Brake Manufacturing Co. 177
Wesche, B. A., Electric Co., The 271
Western Felt Works 268
Westinghouse Electric Corp. 37, 65, 231, 248
Wheelock, Lovejoy & Co., Inc. 214
Whitney Chain & Manufacturing Co., Division of Whitney-Hanson Industries, Inc. 46, 47
Wire Belt Company of America 276
Wisconsin Motor Corp. 264
Wolverine Tube Division, Calumet and Hecla Consolidated Copper Co., Inc. 181

Engineers Available or Wanted 276

"Are you telling Me that I don't know how to Count?"

—exploded the chief engineer



NO *SIR*, chief—not *you!* Only meant to suggest that your swell new machine might do itself much prouder, saleswise, if it only—so to speak—could "learn to count." That's all.

But that's a lot! Many machines that have been "taught to count" . . . with a Veeder-Root Counter built-in as original equipment . . . have shown some startling sales-spurts. For this unique feature gives any product a new usefulness, a new sales appeal, a new distinction from competition. And there *are* golden probabilities that *your own product* has hidden talents in functional service which a built-in Veeder-Root Counter can build up into something big. Such talents may hide themselves from you . . . but not from the creative, mathematical eye of a Counting House engineer. He'll be glad to take a look, any time you say.

COUNTING DEVICES

NEW GENERAL-PURPOSE COUNTER
is modern, streamlined, compact . . . fits readily into most design-limits. Attractive to look at, easy to read. Send for 8-page Condensed Catalog and complete spec-sheet on this counter, No. 1260. Write to

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In Canada: Veeder-Root of Canada, Ltd., 955 St. James Street, Montreal 3. *In Great Britain:* Veeder-Root Ltd., Kilspindie Road, Dundee, Scotland.

Make this note on your Xmas List:

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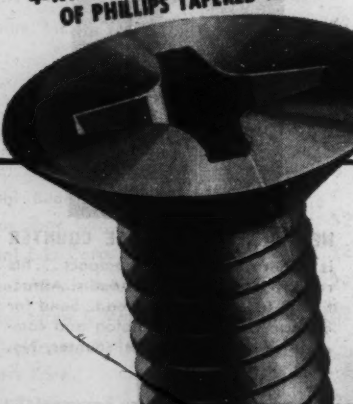
a Quality
Xmas
Gift

All through the dazzling displays, from toys to TV sets, you'll see . . . time and time again . . . the familiar face of the American Phillips Cross Recessed Head Screw. And whenever you see it, you're looking at a top product in its line . . . one that's obviously an exceptionally good buy because it's put together to stay, to withstand vibration and strenuous daily use. What's more, you can be sure that the lucky one who gets your gift *will see it the same way.*

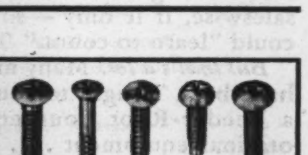
Yes, American Phillips Screws are one of the most reliable outward signs of built-in quality. And if *you* are concerned with the manufacture of any product, then you may well have a far happier New Year in store for you, if you will let us show you how . . . in your own plant as in all others . . . *American Phillips Screws always cost least to use.*

4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS

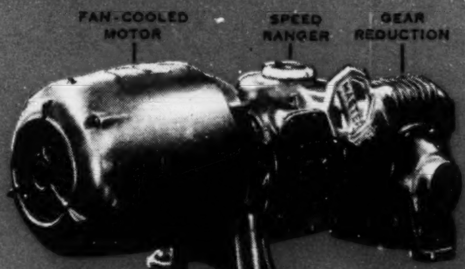


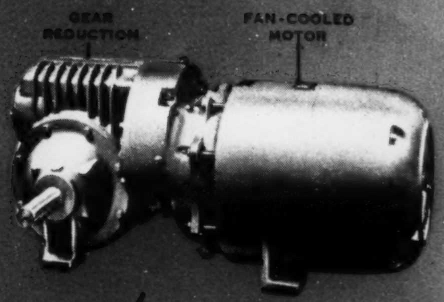
AMERICAN SCREW COMPANY, Main Office: Providence 1, R. I.
Plants at Willimantic, Conn., and Norristown, Pa.
Warehouses at: *Chicago 11:* 589 E. Illinois St. **Detroit 2: 502 Stephenson Building**

AMERICAN PHILLIPS *Screws*



ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)





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You too can give your jobs that extra punch by taking advantage of Master's unusual ability to give you the RIGHT horsepower, the RIGHT shaft speed, the RIGHT construction features, the RIGHT mounting . . . all combined into one compact power package.

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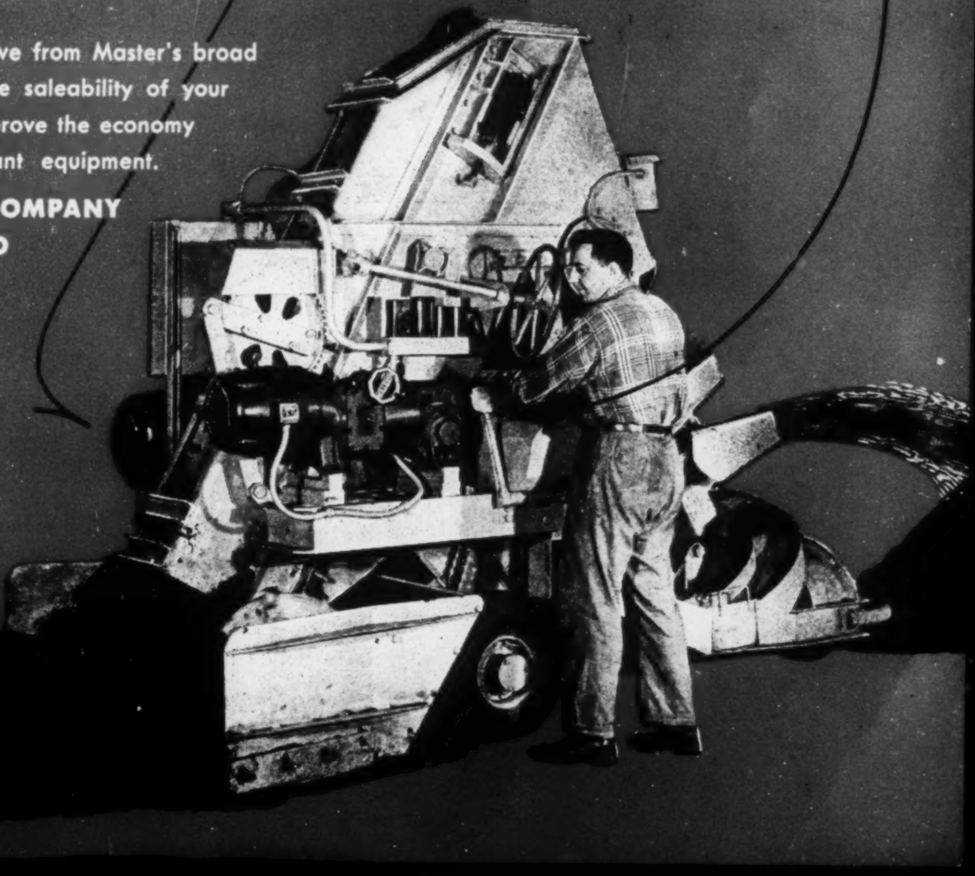


Le Blond singles out TIMKEN® bearings for new double-duty spindle

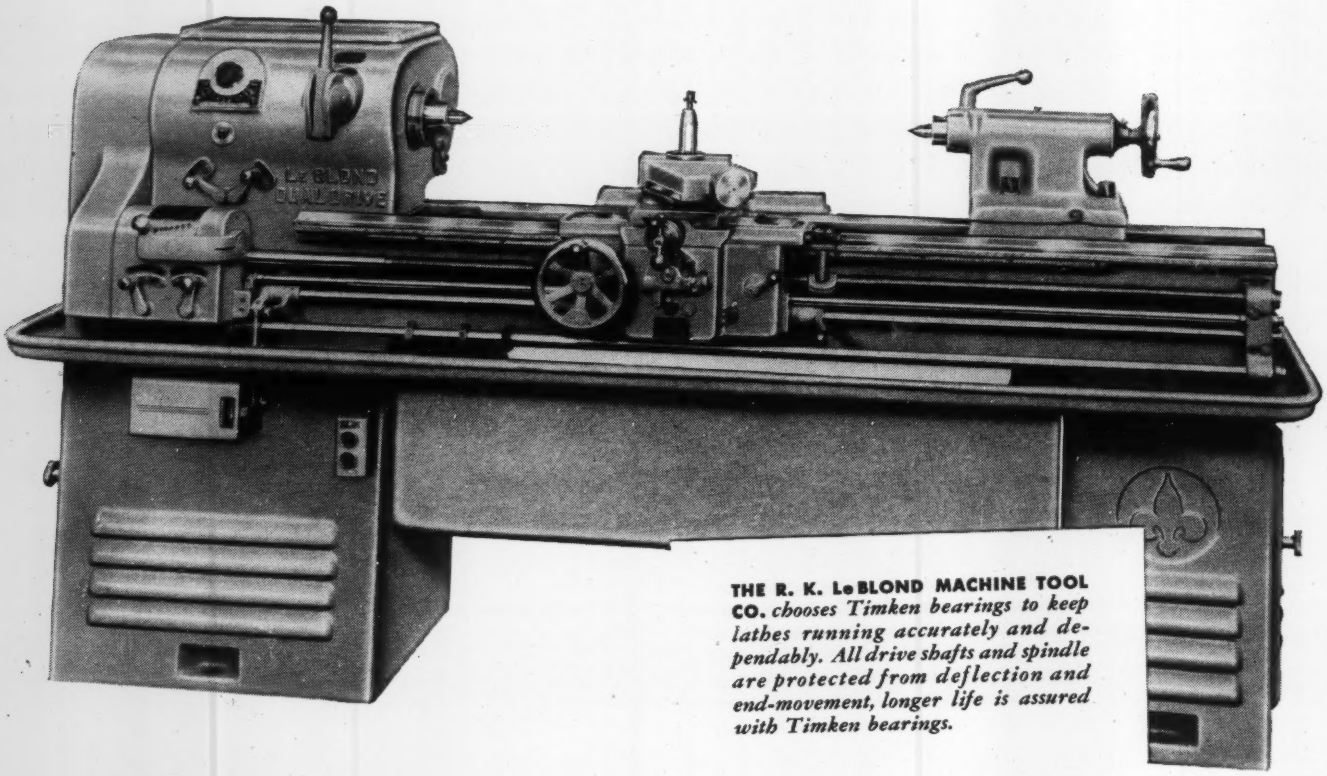
THIS LeBlond lathe—recently re-designed to include an electric brake and hardened and ground Timken® steel bedways—assures accuracy and trouble-free operation with Timken tapered roller bearings on the drive shafts and spindle.

The tapered construction of Timken bearings enables them to carry tremendous radial and thrust loads in any combination. Deflection and end-movement are eliminated. Accurate pre-loading is permitted to any degree. Because wear is negligible, Timken bearings enable spindles and shafts to retain their original accuracy over long years of service.

Maximum load carrying capacity is provided for Timken tapered roller bearings by line contact between the rolls and races. And both rolls and races are made of fine Timken alloy steel for toughness, case hardened for exceptional resistance to wear, finished to incredible smoothness for virtually friction-free operation. Normally, Timken bearings will last the life of the machine.

No other bearings give you *all* the advantages you get with Timken bearings. Whether you're a builder or buyer—make sure every machine is equipped with Timken bearings. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, O. Cable address: "TIMROSCO."

TIMKEN BEARING EQUIPPED *This symbol on a product means its bearings are the best.*



THE R. K. LeBLOND MACHINE TOOL CO. *chooses Timken bearings to keep lathes running accurately and dependably. All drive shafts and spindle are protected from deflection and end-movement, longer life is assured with Timken bearings.*

WITHIN ONE HALF A THOUSANDTH OF AN INCH!

. . . that's an example of the accuracy demanded in the outside diameter of Timken bearing cups in order to pass inspection.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis Timken steels.

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TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

TIMKEN 1899 50 1949 YEARS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ▯ AND THRUST ▯ LOADS OR ANY COMBINATION